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Geo-demographic analysis in support of the United States Army Reserve (USAR) unit positioning and quality assessment model (UPQUAM) Part II

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THESIS

GEO-DEMOGRAPHIC ANALYSIS IN SUPPORT OF THE UNITED STATES ARMY RESERVE (USAR) UNIT POSITIONING AND QUALITY ASSESSMENT MODEL (UPQUAM), PART II

by

Gary S. Tatro

June 2005

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13. ABSTRACT (maximum 200 words)

This thesis is the second part of a three-part thesis study that was started by LTC Martin Fair in June 2004. In his initial thesis, LTC Fair built a database by joining information from the U.S. Census Bureau, U.S. zip codes, and USAR zip code data. LTC Fair also formulated a network flow model and began an initial implementation of the first of many constraints. My thesis will validate the constraint models and develop the set of constraints that another project, by LTC Brau, will need to develop the network flow model. That model will optimize reserve unit readiness in the third and perhaps final part of the study. Since the early 1990's and the demise of the Cold War, the United States Army active and reserve forces have undergone dramatic restructuring. The Active component was reduced in size from 18 active divisions down to today's total of ten - a force cut of approximately 300,000 soldiers. Additionally, the United States Army Reserve forces mission shifted to a predominately Combat Support (CS) and Combat Service Support (CSS) mission. This realignment was an attempt to use the USAR component in a support role as the world situation dictated. Since the terrorist attacks of September 11, 2001, and the subsequent declaration of a "War on Terrorism," the United States Army Reserve (and active component) has been called upon to deploy more frequently and for extended periods of time. Maintaining unit readiness and a satisfactory "fill-rate" is probably one of the leading challenges that our reserve forces face. This thesis examines the relationship between unit location and recruiting success. We seek to maximize the fill rate of United States Army Reserve (USAR) units. Our method will correlate the vocational aptitudes of the US population with the Military Occupational Specialties (MOS) of the USAR units.

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GEO-DEMOGRAPHIC ANALYSIS IN SUPPORT OF THE UNITED STATES ARMY RESERVE (USAR) UNIT POSITIONING AND QUALITY ASSESSMENT MODEL (UPQUAM), PART II

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ABSTRACT

Maintaining unit readiness and a satisfactory unit "fill-rate" is one of the leading challenges of the United States Army Reserve (USAR). This thesis is the second part of a three-part thesis study that was started by LTC Martin Fair in June 2004 to better position United States Army Reserve (USAR) units. In his thesis, LTC Fair surmised that demographics matter in terms of Troop Program Unit (TPU) placement and the corresponding unit fill-rate. LTC Fair built a database by joining information from the U.S. Census Bureau, U.S. zip codes, and USAR zip code data. LTC Fair also formulated an initial network flow model and began an implementation of the first of many constraints.

This thesis examined the relationship between unit location and recruiting success. We were able to validate LTC Fair's constraint models and developed the Military Occupational Specialties (MOS) data sets that show demographics play an important role in determining the percentage of qualified recruits by MOS and ZIP code. Another Naval Postgraduate Student, LTC John Brau, will use these data sets to develop the network flow model, in the third part of this study. That model will optimize reserve unit readiness by positioning TPU's in market segments that are best able to maximize their fill-rate.

This research provides the USAR a workable model that takes into account factors such as unit positioning, recruit quality, and includes demographic considerations to determine potential recruiting success by MOS and ZIP code.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACRONYM	DEFINITION
AFQT	Armed Forces Qualification Test
AIT	Advanced Individual Training
ARCOM	Army Reserve Command
ARNG	Army National Guard
ASVAB	Armed Forces Vocational Aptitude Battery
BLS	Bureau of Labor and Statistics
BOLC	Basic Officer Leadership Course
CAR	Chief of the Army Reserve
CONUS	Continental United States
CONUSA	Continental United States Army
DLAB	Defense Language Aptitude Battery
FEMA	Federal Emergency Management Area
FIP	Federal Information Partnership
FY	Fiscal Year
IET	Individual Entry Training
LAU	Local Area Unemployment
LAUCNTY	Local Area Unemployment -County
LM	Linear Model
LP	Linear Programming
LSCAT	Line Score Category
MAP	Military Available Population
MEPS	Military Entrance and Examination Processing Station
MOS	Military Occupational Specialty
MSO	Mandatory Service Obligation
MSS	Market Supportability Study
NPS	Non-Prior Service

ACRONYM	DEFINITION
OCAR	Office of the Chief of the Army Reserve
PS	Prior Service
RA	Regular Army
RC	Reserve Center
RSC	Regional Support Command
TPU	Troop Program Unit
TTHS	Troops, Transients, Holdees, and Students
UPQUAM	Unit Positioning and QUality Assessment Model
USAR	United States Army Reserve
USARC	United States Army Reserve Command
USAREC	United States Army Recruiting Command
USBC	United States Bureau of the Census
USPS	United States Postal Service
WOLC	Warrant Officer Leadership Course
ZIP	Zone Improvement Plan

EXECUTIVE SUMMARY

Maintaining unit readiness and a satisfactory unit “fill-rate” is one of the leading challenges of the United States Army Reserve (USAR). In his thesis in June 2004, LTC Martin Fair laid the foundation for an optimization model that considers unit manning in correlation to the Military Available Population (MAP). His thesis was the first of three theses that, when combined, form the Unit Positioning and Quality Assessment Model (UPQUAM). LTC Fair surmised that reserve unit “fill-rate” could be optimized by pairing key Military Occupational Specialties (MOS’s) to Reserve Center locations, while taking into account regional demographics. He built a database containing six years of historical data consisting of 30,000 zip codes, 800 Reserve Centers (RC’s), and 264 Military Occupational Specialties (MOSs) that includes demographic, vocational, and economic data and past military recruit production. He also provided an initial optimization model.

This thesis examines the relationship between unit location and recruiting success for each ZIP code in the United States. We were able to validate the premise for LTC Fair’s initial Unit Positioning and QUality Assessment Model (UPQUAM), which was that regional demographics could make a difference as to how we recruit. Also, we developed the set of constraints that determines the maximum number of recruits for each of the 29,865 ZIP codes of the United States, and the maximum number of recruits for each ZIP code and for each of the 264 MOS’s of the USAR. Additionally, we were able to show that there exists variation in demographics between ZIP codes and that these differences can play an important role in determining the percentage of qualified recruits by MOS and ZIP code. We were also able to show that there exists variation between ZIP codes in regards to propensity to enlist in the USAR.

This thesis provides the completed data sets by MOS and ZIP code that forms the basis for an optimization model developed by another Naval Postgraduate School student, LTC John Brau in the third part of this study. His model determines if each TPU is located in a Reserve Center (RC) that can best support its personnel requirements.

The combination of these three theses provides the USAR with a workable network model that accounts for factors such as unit positioning, recruit quality, and includes demographic considerations when determining recruiting success by ZIP code and MOS.

I. INTRODUCTION

A. FOREWORD

In June 2004, Naval Postgraduate Student LTC Martin L. Fair wrote the first part of a three-thesis sequence. In his thesis, LTC Fair proposed that the fill-rate of United States Army Reserve (USAR) Troop Program Units (TPUs) is directly affected by the population demographics of the surrounding communities. He developed an optimization model that will provide the USAR a list of Troop Program Units that would increase their personnel fill-rate if they were located in a market that is more suitable for their particular Military Occupational Specialty (MOS) structure.

The focus of this thesis is to validate LTC Fair's initial Unit Positioning and QUality Assessment Model (UPQUAM) and to determine the maximum number of recruits for each ZIP code, and the maximum number of recruits for each ZIP code by MOS. This information will form the basis for the set of constraints for the final optimization model being developed by another Naval Postgraduate School student, LTC John Brau, in the third thesis of this study. His model will locate each TPU in a Reserve Center (RC) that can best support its personnel requirements.

The combined goal of these three theses is to provide to USAR a workable model for positioning reserve TPUs that accounts for recruit quality, and that includes demographic considerations to determine potential recruiting success by MOS.

B. BACKGROUND

Since the early 1990's and the end of the Cold War, the United States Army active and reserve forces have undergone a dramatic restructuring. The active Army component has been reduced in size from 18 active divisions down to ten – a force cut of approximately 300,000 soldiers. Additionally, the United States Army Reserve (USAR) mission has shifted to a predominately Combat Support (CS) and Combat Service Support (CSS) mission. This realignment was an attempt to integrate the USAR component in a support role for active army forces as the world situation dictates.

Since the terrorist attacks of September 11, 2001, and the subsequent presidential declaration of a "War on Terrorism," the United States Army and Army Reserve are

being called upon to deploy more and more frequently and for extended periods of time. Never since the creation of the all-volunteer military forces have reserve soldiers so frequently been called upon time and again to leave their loved ones and their civilian jobs behind.

> Since America was attacked on September 11, 2001, the Army Reserve has mobilized more than 126,000 (as of Jan. 26, 2005) Army Reserve Soldiers for the Global War. Never in the history of our 96-year old organization has this country depended on the Army Reserve more than they do today. Yet, the experience of the last three years shows the Army Reserve must re-structure to be the agile, adaptive, and rotationally-based force that the Army and Joint Forces need. [1]

Lt. Gen. James Helmly
Chief, Army Reserve
Commanding General, U. S. Army Reserve Command

Although it is still too early to tell what the overall effect this increase in operations tempo (OPTEMPO) will have on the USAR recruiting mission, initial indications are that the Regular Army and USAR recruiting mission will face near- and possibly long-term recruiting challenges. According to a recent article appearing in the Army Times, "as of 1 March 2005, the Regular Army has fallen short of its 2005 recruiting goal of 29,185 by 1,823 soldiers (about 6.3%), and the USAR missed its recruiting mission by 643 soldiers (about 10.3%)."[2]

Maintaining unit readiness and a satisfactory unit "fill-rate" is probably one of the leading challenges that our reserve forces face. In his thesis in June 2004, LTC Martin Fair laid the foundation for an optimization model that considers unit manning in correlation to the Military Available Population (MAP). His thesis was the first of three theses that, when combined, will form the Unit Positioning and Quality Assessment Model (UPQUAM). In his thesis, LTC Fair surmised that reserve unit "fill-rate" could be optimized by pairing key Military Occupational Specialties (MOS's) to Reserve Center locations, while taking into account regional demographics. He built a database containing six years of historical data consisting of 30,000 zip codes, 800 Reserve

[1] LTG Helmly, Chief, Army Reserve Addresses "Courage to Change" in the Army Reserve, Spring 2005.

[2] Article, "Regular Army falls short of recruiting goal," Army Times, March 14 2005, page 10.

Centers (RC's), and 264 Military Occupational Specialties (MOSs) that includes demographic, vocational, and economic data and past military recruit production. He also provided an initial optimization model.

This thesis examines the relationship between unit location and recruiting success for every ZIP code in the U.S. We predict the number of expected recruits and the MOS's to which they could be assigned. This provides the constraints for the optimization model for the third and final thesis, being written by LTC John Brau. Our combined theses seek to maximize the fill-rate of United States Army Reserve (USAR) units. Our method will correlate the vocational aptitudes of the United States population with the Military Occupational Specialties of the USAR.

C. MISSION AND ORGANIZATION OF THE UNITED STATES ARMY RESERVE

Under Title 10 of the U.S. Code, the purpose of the United States Army Reserve "is to provide trained units and qualified persons available for active duty in the armed forces, in time of war or national emergency, and at such other times, as the national security may require, to fill the needs of the armed forces whenever, during and after the period needed to procure and train additional units and qualified persons to achieve the planned mobilization, more units and persons are needed than are in the regular components."[3] The United States Army Reserve forces complement the active army by providing crucial combat support and combat service support personnel and units. United States Army Reserve unit "fill-rate" depends on the ability of USAR recruiters to attract qualified applicants for enlistment into MOS's needed by the TPU's.

The United States Army is organized into three basic components: Active Duty Soldiers, the Army Reserve, and the Army National Guard. This thesis is limited to discussion of only the Army Reserve component. The method, however, could be modified for use by the Army National Guard (ARNG).

The Army Reserve is a force of highly trained Soldiers ready to augment and support the Active Army at a moment's notice. Army Reserve Soldiers serve in more

[3] Title 10, Armed Forces, subtitle E – Reserve Components, Chapter 1003 – Reserve Components Generally, section 10102.

than 2,000 units in the United States, Guam, the Virgin Islands, Puerto Rico and Germany.[4]

D. COMPOSITION OF THE ARMY RESERVE

Three main groups of soldiers comprise the Army Reserve: the Selected Reserve, the Individual Ready Reserve (IRR) and the Retired Reserve. The combined strength of these components number over one million soldiers. This thesis will focus only on the Selected Reserves. Figure 1 is a schematic of the basic structure of the Reserve Component.

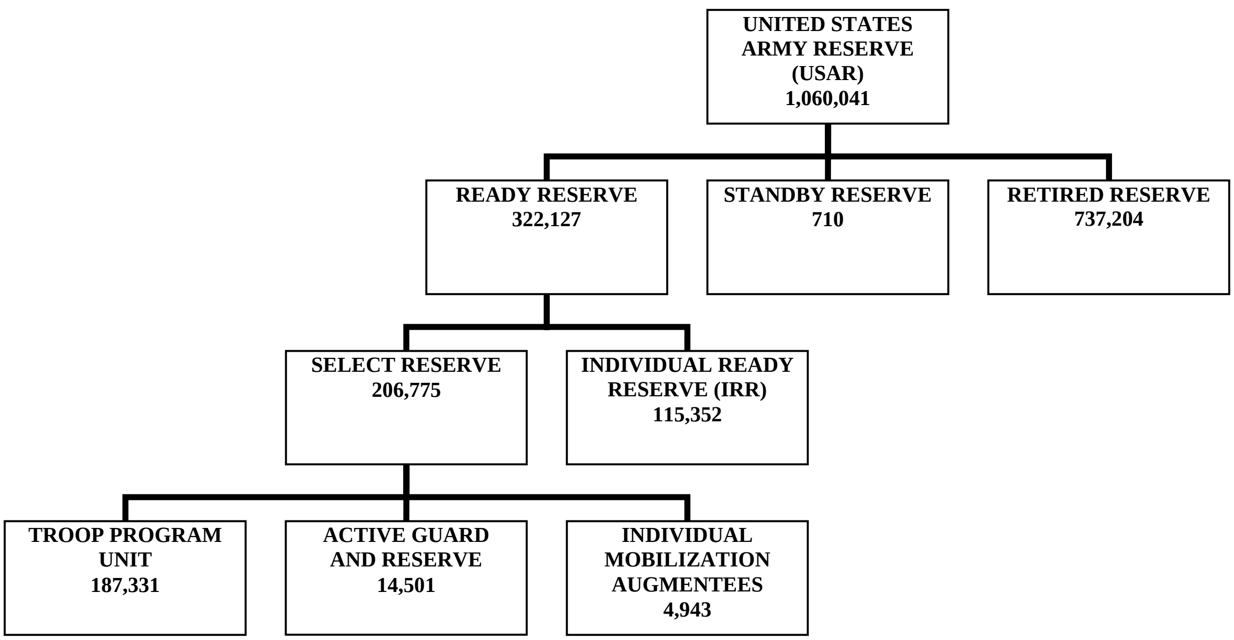

Figure 1. Structure of the Reserve Component[5]

The Selected Reserve is comprised of soldiers assigned to Troop Program Units (TPUs), Active Guard and Reserve (AGR) Soldiers, and Individual Mobilization Augmentees (IMAs), and is the group of Reserve Soldiers most accessible for mobilization by the President in case of war or declaration of a national emergency.

4 United Status Army Reserve Web Site (Retrieved 29 January 2005). Retrieved from (http://www.armyreserve.army.mil/usar/organization/default.aspx)

5 United Status Army Reserve Web Site (Retrieved 29 January 2005). Retrieved from (http://www.armyreserve.army.mil/usar/organization/People/ForceComp.aspx)

"TPU Soldiers serve in over 2,000 TPUs nationwide and have an authorized end-strength of more than 185,000 Soldiers."[6] Below, Figure 2 shows the current location of TPUs. Troop Program Unit Soldiers historically have trained one weekend a month and two weeks a year during their annual training. However, this role has changed in recent years and the reserves are being called upon to deploy frequently and for extended periods.

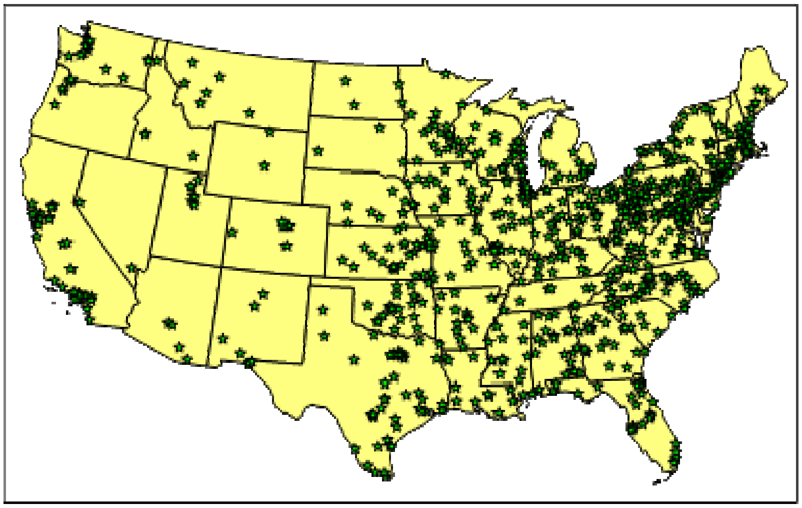

Figure 2. Locations of USAR TPUs[7]

AGR Soldiers serve full-time on active duty in organizations in direct support of the Army Reserve. For all intent and purposes, these are active duty Soldiers serving full-time supporting the USAR. They enjoy the same pay and benefits as their Regular Army counterparts, but serve in a support role that cannot be accomplished by part-time Soldiers.

An Individual Mobilization Augmentee (IMAs) is by definition "an individual reservist attending drills who receives training and is preassigned to an active component organization, a Selective Service System, or a Federal Emergency Management Agency billet that must be filled on, or shortly after, mobilization. Individual Mobilization

[6] United Status Army Reserve Web Site (Retrieved 29 January 2005). Retrieved from (http://www.armyreserve.army.mil/usar/organization/People/ForceComp.aspx)

[7] Fair, Geo-Demographic Analysis in Support of the US Army Reserve Unit Positioning and QUality Assessment Model (UPQUAM), June 2004, page 36

Augmentees train on a part-time basis with these organizations to prepare for mobilization. Most IMAs train annually for two weeks."[8]

E. OBJECTIVES OF THIS RESEARCH

The two main objectives of this research are as follows:

1. To validate LTC Fair's initial Unit Positioning and QUality Assessment Model (UPQUAM) and determine the maximum number of recruits for each ZIP code, and the maximum number of recruits for each ZIP code by MOS.

2. To populate the MOS Data Fields for the Optimization Model utilized by LTC John Brau in the third part of this study. LTC Brau's model will determine if each TPU is located in a Reserve Center (RC) that can best support its personnel requirements.

F. SCOPE AND LIMITATIONS OF THIS THESIS

This thesis used linear regression techniques to develop the potential MOS structure with regards to the local recruiting market. Using S-Plus, we validated LTC Fair's initial regression models and develop the constraint data sets necessary for the optimization model in the third part of this study. Finally, we analyzed these data sets to determine whether population demographic composition amongst various ZIP codes make a difference to recruitment and unit TPU fill-rate.

This thesis takes into account only the personnel rank structure in the Non-Prior Service (NPS) pay grades of E-1 through E-4. This assumes that those units that have an adequate fill-rate of junior enlisted soldiers can promote from within the ranks to address the needs of their Noncommissioned Officer Corps.

This thesis does not address Officer fill-rates of the USAR Reserve Centers because they require a different type of analysis. That could be the topic of a follow-on thesis.

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[8] United States Army Reserve Web Site (Retrieved 24 January 05). Retrieved from http://www.goarmy.com/reserve/nps/army_reserve_force_structure.jsp

II. PROBLEM STATEMENT

A. PROBLEM BACKGROUND

Part of the United States Army Reserve mission is to recruit and induct qualified individuals to assure the reserves can maintain an adequate force structure to support ongoing missions. The United States Army Reserve recruits from two separate and distinct candidate populations. These are the Non-Prior Service (NPS) and the Prior Service (PS) markets. The United States Army Recruiting Command (USAREC) is responsible for recruitment of the NPS segment while the USAR is responsible for recruiting PS individuals. These two sets of recruiting candidates form the Military Available Population (MAP) and range in age from 17-34 (Fair, 2004).

The PS candidates are those soldiers that have some form of prior military service whether it was in the active Army component or another branch of the armed services. These individuals incur a Mandatory Service Obligation (MSO) totaling eight years at the time of their initial enlistment. PS recruits can be transferred from the IRR and placed into a unit within the Selected Reserve.

The NPS candidates are those without prior military service. Generally, recruitment of these individuals is from an area near a local Reserve Center (RC) – usually within a 75-mile radius or a 90-minute commute time. Once enlisted, these candidates are placed into a Trainees, Transient, Holdees, and Students (TTHS) account pending completion of their Initial Entry Training (IET), which consists of basic training and their MOS-specific training.

In the past, billets occupied by these soldiers and others in a similar status (such as officers awaiting attendance at either the Basic Officer Leadership Course (BOLC) or the Warrant Officer Basic Course (WOBC), and PS enlisted soldiers awaiting MOS training for a position in the USAR), would negatively affect a reserve unit's readiness. The degradation of unit readiness was a result of soldiers not being qualified for duty in their MOS being placed in reserve unit jobs when in reality these individuals are considered non-deployable until completion of training in their duty MOS.

Administratively, these recruits were filling job positions that could have been given to a fully qualified individual.

> Today, we recruit between 18,000 and 20,000 non-prior service young men and women each year. Every one of them is assigned to a unit while they are in Basic and AIT or split option. However, they count against the unit and they block a position. Another case in point ... a Soldier comes from active duty and is not MOS-qualified. He or she is blocking a position that counts against the readiness of the unit.[9]
>
> Lt. Gen. James Helmly

As of Fiscal Year 2005, this has changed through the creation of the TTHS account for the USAR. The addition of the TTHS account is largely an administrative measure that places soldiers who are awaiting training, pending discharge, or other administrative type measures, into a separate account so that they do not count against a reserve unit's billets. The effect of this measure is to produce additional vacancies in reserve units that can then be filled with qualified, deployable personnel.

B. BENEFITS OF THIS THESIS

Currently, assignment of USAR units to Reserve Centers is based on Market Supportability Studies (MSS) provided by the United States Army Recruiting Command (USAREC). Generally, these studies are based on "Military Available Population (MAP), past production, unit losses, and other Army Reserve and National Guard units within the unit's distance and driving time constraints."[10] While beneficial, these studies do not take into consideration things such as local market vocational propensity/composition and market quality. The focus of this thesis is to validate the initial Unit Positioning and QUality Assessment Model (UPQUAM) began by LTC Fair in June 2004; and to provide the constraints for all 264 MOSs of the USAR by zip code for the Optimization Model utilized by LTC John Brau in the third part of this study. The combined goal of these three theses is to provide a workable model that takes into account factors such as unit positioning, recruit quality, and that includes demographic considerations to determine potential recruiting success by MOS.

[9] Article, "Lt. Gen. James R. Helmly speaks out on change," Army Reserve Magazine, April 30, 2004

[10] Phone interview with MAJ Robert Radke, USAREC PAE, MSS Division, 03FEB 05

III. METHODOLOGY

A. INTRODUCTION

This chapter details the study design, which is based on the model started by LTC Fair in part I of this study. This purpose of the model is to be able to provide the USAR a list of Troop Program Units that would increase their personnel fill-rate if they were located in a market that is more suitable for their particular MOS structure. The focus of my thesis is to determine the maximum number of recruits for each zip code, and the maximum number of recruits for each zip code by MOS. LTC Brau will use these results for the optimization model. His model will determine if each TPU is located in a Reserve Center that can support its personnel requirements.

B. DATA COLLECTION

The data source collection for this study was a time intensive project completed in large part by LTC Fair in his original thesis and updated to include more recent data. He used Microsoft FoxPro and Clementine software to merge many different data sets (see sources below) into one usable file. The data took several months to collect and consolidate. It was collected from almost a dozen different sources (see appendices A and B for more detail) and when consolidated into a single database forms a data matrix comprised of almost 30,000 zip codes by 292 predictor and categorization variables.

C. SOURCES OF DATA

Appendices A and B contain a data dictionary created by LTC Fair and provide details that describe the sources of the data and the content of the data fields. Major data elements used contained in this study include:

1. The United States Postal Service Zip Code Master File;
2. The Bureau of Labor and Statistics (BLS) Vocational Master File (P050);
3. BLS Local Area Unemployment Data – County (LAUCNTY);

4. BLS General Population Employment Data (gp.data.1.AllData);
5. BLS General Population State Code Data (gp.state);
6. Microvision 50 Lifestyle Segmentation Data (MV50);
7. United States Army Reserve Force Structure File (FRC_FILE);
8. All Army Accessioning Data (ALLARMY);
9. Accessioning Data from the other Reserve Components (SISSERV);
10. MOS Quality (QUALS) Master Data File;
11. USAREC Military Available Population Data (PM03).

D. MODEL

As stated previously, the purpose of the model is to determine the maximum number of recruits for each zip code and the maximum number of recruits for each zip code by MOS. Once completed, LTC Brau will use these MOS models to form the basis of the optimization model. In his thesis, LTC Brau updated the original model formulation constructed by LTC Fair. The table below details the updated model formulation and a detailed description for the optimization model and the many constraints.

INDICES:

z	ZIP codes of interest (00010…99985) [1,…,29,865]
r	Reserve Centers (The current number of RCs) [1,…,829]
u	Units (indexed by Unit Identification Codes, or UICs) [W05LAA,…WZXRAA,1-4268]
m	MOSs of interest (00B…98Z) [1,…,264]

PARAMETERS:

$max\_recruit\_zip_z$	Maximum number of recruits available in ZIP z
$max\_recruit\_zip\_MOS_{z,m}$	Maximum number of recruits available in ZIP z of MOS m
$target_{u,m}$	Target number of recruits for MOS m in Unit u
$weight_m$	Weighting (priority) of MOS m assigned by OCAR
$tier_u$	Tier rating of Unit u assigned by OCAR

NONNEGATIVE VARIABLES (*Note: All variables are non-negative)***:**

$ZIPFLOW_{z,r,m}$	Flow from ZIP Code z to RC r of MOS m
$RC\_FLOW_{r,m}$	Flow through RC r of MOS m
$UNITFLOW_{r,u,m}$	Flow from RC r through UIC u to MOS m
$SLACK_{u,m}$	Shortfall of soldiers in MOS m in UIC u

BINARY VARIABLES:

$ASSOC_{r,u}$ $\begin{cases} 1 & \text{If there is flow from RC } \boldsymbol{r} \text{ to UIC } \boldsymbol{u} \\ 0 & \text{o/w i.e. UIC } \boldsymbol{u} \text{ is not located at RC } \boldsymbol{r} \end{cases}$

FORMULATION:

$$\min \sum_{u,m} weight_m * tier_u * SLACK_{u,m} \qquad (0)$$

$$\text{s.t.} \quad \sum_{r,m} ZIPFLOW_{z,r,m} \le max\_recruit\_zip_z \qquad \forall z \qquad (1)$$

$$\sum_{r} ZIPFLOW_{z,r,m} \le max\_recruit\_zip\_MOS_{z,m} \qquad \forall z, m \qquad (2)$$

$$\sum_{z} ZIPFLOW_{z,r,m} = RC\_FLOW_{r,m} \qquad \forall r, m \qquad (3)$$

$$RC\_FLOW_{r,m} = \sum_{u} UNITFLOW_{r,u,m} \qquad \forall r, m \qquad (4)$$

$$\sum_{r} ASSOC_{r,u} \le 1 \qquad \forall u \qquad (5)$$

$$\sum_{r} UNITFLOW_{r,u,m} + SLACK_{u,m} \ge target_{u,m} \qquad \forall u, m \qquad (6)$$

$$UNITFLOW_{r,u,m} \le target_{u,m} * ASSOC_{r,u} \qquad \forall r, u, m \qquad (7)$$

The objective function increases unit fill to a specified target captured in parameter $target_{m,u}$ for as many units as possible by associating (i.e. stationing) TPUs to RC's based on recruiting market supportability while identifying RCs for closure. Closing RCs could result in cost benefits for the USAR. Furthermore, the objective function prioritizes MOS fill based on the CAR's "Sweet Sixteen" priority MOSs and a unit's tier rating.

Constraint (1) limits the number of recruits per Zip Code to its maximum level determined via regression analysis

Constraint (2) limits the number of recruits in a given MOS per Zip Code to its maximum level determined via regression analysis

Constraint (3) is a balance-of-flow constraint that ensures the total flow from zip code *z* of MOS m to RC *r* is equal to the flow out of RC *r* for MOS *m*

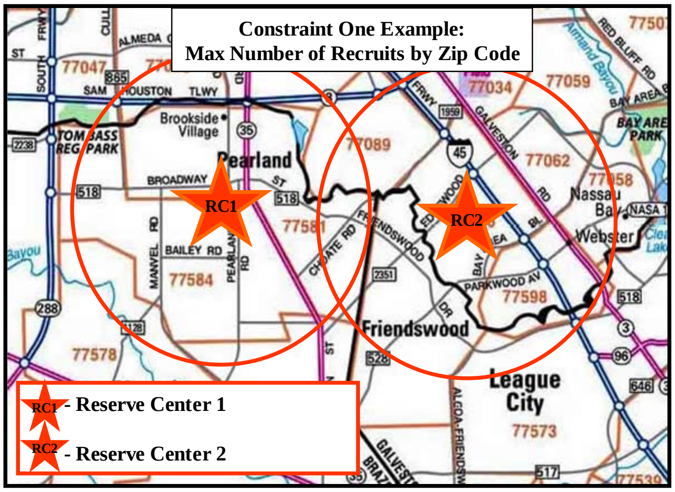
Constraint (4) is a balance of flow constraint that ensures the flow from RC *r* of MOS *m* is equal to the total flow of MOS *m* from RC *r* to UIC *u*.

Constraint (5) is a single-source constraint that ensures a UIC is located at only one RC.

Constraint (6) allows the model to find a feasible solution by using a slack variable. $SLACK_{u,m}$ identifies the shortfall of MOS *u* in UIC *u*.

Constraint (7) regulates the flow from RC *r* of MOS *m* into UIC *u* based on the binary variable $ASSOC_{r,u}$.[11]

The first two constraints are the focus of this thesis. The first constraint limits the maximum number of recruits per ZIP Code. The second constraint limits the maximum number of recruits in a particular MOS for each ZIP Code. Figure 3 and Figure 4 on the next page graphically depict these two constraints.



ZIP Code	Max Number of Recruits
77047	10
77048	8
77075	12
77581	15
77584	8

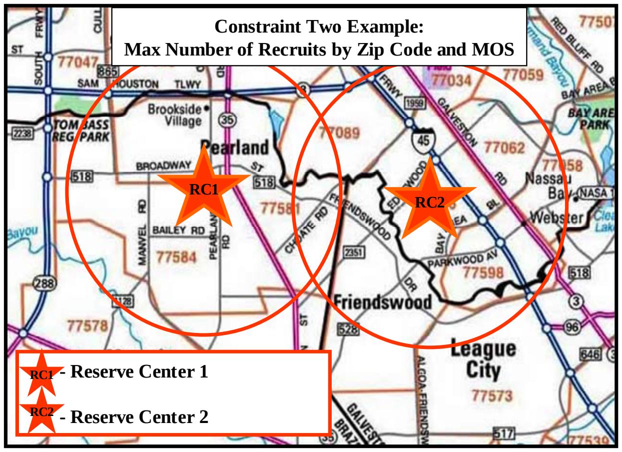
This table depicts the five zip codes associated with Reserve Center 1 and the maximum number of recruits from the Military Available Population (MAP) within each zip code

*** RC's boundaries and recruit numbers are for illustration purposes only.**

Figure 3. Constraint One Example.

This illustration of the first constraint depicts two fictitious Reserve Centers each having multiple area codes within the 75-mile (or 90 minute) radius. The table next to the illustration shows the five zip codes associated with Reserve Center 1 and the maximum number of recruits that can be expected annually from the Military Available Population (MAP). (Source: Gary S. Tatro).

11 Brau, Improving the Quality and Personnel Fill Rates of U.S. Army Reserve Units, June 2005, pages 18-19.



MOS

Zip Codes within a 75-Mile Radius of RC1

ZIP Code	11B	35B	71L	92G
77047	10	5	7	10
77048	8	5	6	8
77075	12	6	7	12
77581	15	9	11	15
77584	8	5	6	8

This table depicts the five zip codes associated with Reserve Center 1 and the maximum number of recruits that qualify for an MOS needed to be filled at Reserve Units at RC1

*** RC's boundaries and recruit numbers are for illustration purposes only.**

Figure 4. Constraint Two Example.

The second example illustrates constraint two, which pertains to the maximum number of recruits by MOS per zip code. The maximum column value (MOS) in this example equal the number of recruits by zip code in constraint one. This means that although there may be ten possible recruits in zip code 77047, not all of them will qualify to enlist for each MOS. For example, in zip code 77047, while all 10 recruits qualify for MOS 11B (Infantry) and MOS 92G (Cook), only five scored well enough on the Armed Forces Vocational Aptitude (ASVAB) Test to qualify to be a 95B (Military Policeman). (Source: Gary S. Tatro).

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IV. ANALYSIS/RESULTS

A. MODEL FITTING

1. Constraint One.

$$\sum_{r,m} \boldsymbol{ZIPFLOW_{z,r,m}} \leq \boldsymbol{max\_recruit\_zip_{z}} \qquad \forall \boldsymbol{z}$$

In his thesis, LTC Fair proposed a model for the first constraint. Using S-Plus (Insightful, 2001), a statistical software program, we will need to validate his model and compare it to several other models prior to running the 264 regressions necessary for Constraint Two.

This constraint is used to predict the annual maximum number of recruits for each ZIP code in the Unites States. Once we identify a credible linear regression model, we will construct a data set consisting of the approximately 30,000 ZIP codes and the prediction for the maximum annual number of recruits expected from each of these ZIP codes.

In the model, the independent variable is Army Reserve Contracts (AR.Cnt). AR.Cnt represents the six-year total number of USAR contracts obtained from each of the corresponding ZIP codes. To obtain an annual prediction, we divide the total number of contracts for each ZIP code by six. The dependent or "regressor" variables consist of 24 predictors. They are the unemployment rate (unrate2), the Military Available Population (MA.POP), 11 vocation categories (EXECMANGE through SALES), and 11 lifestyle segments (MV50GP01 through MV50GP11). Appendices A and B were provided by LTC Fair and contain a thorough description of each of these variables.

For analysis, it would have been better to compare the independent variable (annual production data) to the dependent variables for *each* of the six years because the dependent variables (such as unemployment rate, military available population, etc.) may fluctuate from year-to-year. However, since we did not have this data, we used the aggregate number of contracts for the six-year time period and divided by six to get an annual prediction.

Using the original data and model constructed by LTC Fair, running a linear regression model in S-Plus using the 24 predictor variables yields the following results shown in table 4.1:

```
*** Linear Model ***

Call: lm(formula = AR.Cnt/6 ~ unrate.2 + MA.POP + EXECMNGE + FAFOFISH +
ADMINSPT + PROFSNL + TECHSPT + SVCOTHR + SVCPROT + SALES + CRFTSMAN + LABORERS
+ TRANSPO + MV50GP01 + MV50GP02 + MV50GP03 + MV50GP04 + MV50GP05 + MV50GP06 +
MV50GP07 + MV50GP08 + MV50GP09 + MV50GP10 + MV50GP11, data = ALLDATAbyZIP2a,
na.action = na.exclude)
```

Residuals:	Min	1Q	Median	3Q	Max
	-7.229	-0.2106	-0.05927	0.1448	23.3

Coefficients	**Value**	**Std. Error**	**t value**	**Pr(>|t|)**
(Intercept)	0.1387	0.0151	9.2131	0.0000
unrate.2	-1.5434	0.2260	-6.8296	0.0000
MA.POP	0.0001	0.0000	18.5962	0.0000
EXECMNGE	-0.0002	0.0000	-18.5076	0.0000
FAFOFISH	-0.0006	0.0000	-13.4248	0.0000
ADMINSPT	0.0007	0.0000	23.1083	0.0000
PROFSNL	0.0001	0.0000	4.7457	0.0000
TECHSPT	0.0008	0.0000	24.3689	0.0000
SVCOTHR	0.0001	0.0000	8.7385	0.0000
SVCPROT	0.0003	0.0000	7.6544	0.0000
SALES	0.0000	0.0000	0.3065	0.7592
CRFTSMAN	-0.0002	0.0000	-16.6802	0.0000
LABORERS	-0.0021	0.0003	-7.7205	0.0000
TRANSPO	0.0000	0.0000	1.4496	0.1472
MV50GP01	0.0000	0.0000	1.4457	0.1483
MV50GP02	0.0000	0.0000	5.2419	0.0000
MV50GP03	0.0015	0.0000	40.9521	0.0000
MV50GP04	0.0000	0.0000	-8.0048	0.0000
MV50GP05	-0.0014	0.0002	-6.5834	0.0000
MV50GP06	-0.0003	0.0000	-14.9506	0.0000
MV50GP07	-0.0012	0.0003	-4.3709	0.0000
MV50GP08	0.0001	0.0000	14.9841	0.0000
MV50GP09	-0.0001	0.0000	-9.2615	0.0000
MV50GP10	-0.0014	0.0005	-2.5788	0.0099
MV50GP11	0.0001	0.0001	0.6915	0.4893

```
Residual standard error: 0.8929 on 29840 degrees of freedom
Multiple R-Squared: 0.6934
F-statistic: 2812 on 24 and 29840 degrees of freedom, the p-value is 0
```

Table 4.1: “Full” Model with 24 Predictor variables based on Military Available Population, Unemployment Rate, Vocations, and Lifestyle Segment Categories

The model yields a Multiple R-Squared value of 0.6934, meaning the model can explain approximately 69% of the variance in annual production numbers. Further analysis of the model indicates that the variables for vocations “Sales” and “Transportation” and Lifestyle Segment Categories MV50GP01 and MV50GP11 appear not to contribute significantly to the overall model since their p-values exceed 0.05. In

addition, we see that some of the coefficients are negative. This is likely a result of these variables having a negative association with the number of contracts produced in the zip code. For example, for every 10,000 people working in "craftsman" jobs, the expected number of USAR contracts is expected to decrease by two. In contrast, for every 10,000 people working in "administrative support" jobs, the number of annual USAR contracts is expected to increase by seven.

The variable "Sales" has the highest p-value (0.7592) which means that it is probably not significant to the model. Figure 4.2 below shows what happens to the model if we remove this variable.

```
          *** Linear Model ***

Call: lm(formula = AR.Cnt/6 ~ unrate.2 + MA.POP + EXECMNGE + FAFOFISH +
ADMINSPT + PROFSNL + TECHSPT + SVCOTHR + SVCPROT + CRFTSMAN + LABORERS +
TRANSPO + MV50GP01 + MV50GP02 + MV50GP03 + MV50GP04 + MV50GP05 + MV50GP06 +
MV50GP07 + MV50GP08 + MV50GP09 + MV50GP10 + MV50GP11, data = ALLDATAbyZIP2a,
na.action = na.exclude)

Residuals:   Min      1Q   Median     3Q   Max
           -7.23 -0.2103 -0.05921 0.1446 23.29
```

Coefficients:	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.1385	0.0150	9.2095	0.0000
unrate.2	-1.5413	0.2259	-6.8235	0.0000
MA.POP	0.0001	0.0000	19.3729	0.0000
EXECMNGE	-0.0002	0.0000	-20.2898	0.0000
FAFOFISH	-0.0006	0.0000	-13.4529	0.0000
ADMINSPT	0.0007	0.0000	30.3816	0.0000
PROFSNL	0.0001	0.0000	4.9816	0.0000
TECHSPT	0.0009	0.0000	25.6810	0.0000
SVCOTHR	0.0001	0.0000	9.0508	0.0000
SVCPROT	0.0003	0.0000	7.6570	0.0000
CRFTSMAN	-0.0002	0.0000	-16.7001	0.0000
LABORERS	-0.0020	0.0003	-7.7747	0.0000
TRANSPO	0.0000	0.0000	1.4565	0.1453
MV50GP01	0.0000	0.0000	1.5119	0.1306
MV50GP02	0.0000	0.0000	5.3343	0.0000
MV50GP03	0.0015	0.0000	40.9999	0.0000
MV50GP04	0.0000	0.0000	-8.0047	0.0000
MV50GP05	-0.0014	0.0002	-6.5854	0.0000
MV50GP06	-0.0003	0.0000	-15.1106	0.0000
MV50GP07	-0.0012	0.0003	-4.3930	0.0000
MV50GP08	0.0001	0.0000	14.9985	0.0000
MV50GP09	-0.0001	0.0000	-9.3267	0.0000
MV50GP10	-0.0014	0.0005	-2.5818	0.0098
MV50GP11	0.0001	0.0001	0.6959	0.4865

```
Residual standard error: 0.8929 on 29841 degrees of freedom
Multiple R-Squared: 0.6934
F-statistic: 2934 on 23 and 29841 degrees of freedom, the p-value is 0
```

Table 4.2: Full Model Minus Variable "Sales"

While it seems logical that all 24 of the predictor variables should be important to the model (since they are based on the demographic composition of the market), it appears that by removing the variable "Sales," the model does not significantly change. The amount of explained variation is the same to four decimal places (R-Squared value of 0.6934).

We developed several more models for comparison to the original (see Appendix C). We chose these models by performing a step-wise (Step AIC) comparison and by backwards elimination – meaning variables were removed from the model that appeared insignificant after each regression. Table 4.3 below provides a summary of these results. The complete regression results for all models are contained in Appendix C.

MODEL	R-SQUARED VALUE	DEGREES OF FREEDOM
FULL MODEL (WITH 24 PREDICTOR VARIABLES)	0.6934	24
FULL MODEL MINUS SALES	0.6934	23
FULL MODEL MINUS SALES AND TRANSPO	0.6934	22
FULL MODEL MINUS UN.RATE AND MAP	0.6893	22
FULL MODEL MINUS SALES,TRANSPORTATION, AND MV50GP11	0.6933	21
FULL MODEL MINUS SALES, TRANSPORTATION, MV50GP11, AND MV50GP01	0.6933	20
FULL MODEL MINUS LIFESTYLE SEGMENTS	0.6576	13
FULL MODEL MINUS VOCATIONS	0.6457	13
FULL MODEL MINUS VOCATIONS, UN.RATE AND MAP	0.6283	11
FULL MODEL MINUS LIFESTYLE SEGMENTS, UN.RATE AND MAP	0.6528	11
FULL MODEL MINUS LIFSTYLE SEGMENTS AND VOCATIONS	0.5432	2

Table 4.3: Comparison Summary of Various Regression Models for Constraint One

Comparison of the 11 models indicates that the variation between them is relatively minor for the first six models. After that, we begin to see a more noticeable change. The "Full" model with 24 degrees of freedom is only 0.01 percent better in R-

Squared than the model with four predictor variables removed (Full Model minus Sales, Transportation, MV50GP11, and MV50GP01) and which contains 20 degrees of freedom. Comparing the "Full" model to the model with the lifestyle segments removed (13 degrees of freedom) shows an overall decrease of about 4% in the explained variation. Similar results occur when running the model with the "vocation" variables removed. Overall, a comparison of these models leads us to conclude that the model is changing, although at times negligibly, dependent on which variables are included. For practical purposes, the amount of variation between all but the very last models is insignificant.

Although, a model with fewer variables is usually preferred, the basis of the thesis began by LTC Fair, continued in this research, and culminating with an optimization model by LTC Brau is to optimize United States Army Reserve unit "fill-rate" based on market composition. Logically, it makes sense to include all demographic composition variables (vocation and lifestyle segments) in the model as a consideration for further research. Therefore, all 24 regressor variables are included in the model to complete the MOS-build for constraint two.

2. Assessing Model Adequacy

The next step is to determine the adequacy of our model. A good way to accomplish this is by a normal probability plot of the standardized residuals (Devore, 2004). Since we assumed the residuals were "normal" and possessed constant variance, we expect an equal number of data points to be plotted above and below the regression line. Depicted on the next page is a plot of our model in Figure 5.

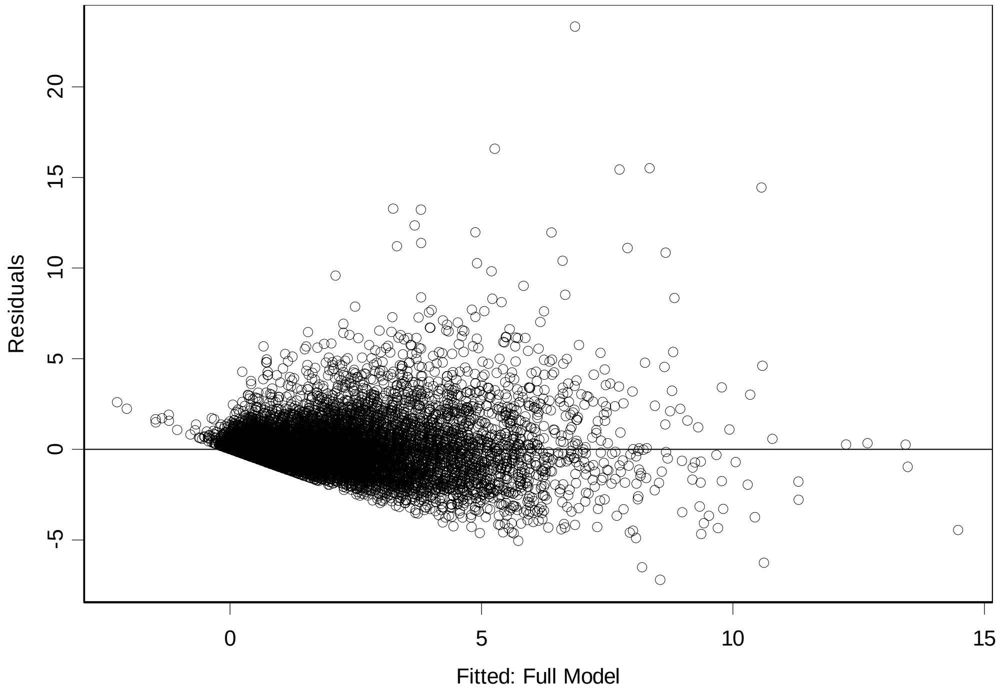

Figure 5. Full Model: Fitted vs. Residuals

Figure 5 shows a graph of the fitted average number of annual contracts versus the residuals. Note the general "football-type" shape formed along the regression line. Although not perfect, this shows that the residuals generally have constant variance. Given that there are almost 30,000 observations in the data set and the preponderance of residuals appear to be normally distributed and of equal variance, we determined that we can use this model. In addition, the bottom left portion of the graph shows there is a linear boundary formed by the residuals. This is because the number of contracts is either zero or a positive value.

Rather than include the regression results for each of the 29,865 ZIP codes, we constructed a table for the first 20 ZIP codes. Depicted in Table 4.4 on the next page are the regression results for these ZIP codes.

Zip Codes	Constraint One
01001	1.77
01002	4.63
01003	0.09
01005	0.58
01007	1.49
01008	0.17
01010	0.27
01011	0.21
01012	0.12
01013	2.37
01020	3.31
01022	0.39
01026	0.23
01027	1.91
01028	1.20
01030	1.43
01031	0.29
01032	0.11
01033	0.75
01034	0.16

Table 4.4: Prediction of the Maximum Annual Number of Recruits for the first 20 ZIP Codes

Table 4.4 indicates that holding all else constant; some ZIP codes are more likely to produce USAR contracts than others are. For example, ZIP code 01002 is predicted to produce an annual average of 4.63 contracts while ZIP code 01032 is predicted to produce only an annual average of .11 contracts. USAR recruiters could use this information to concentrate their recruitment effort in these market segments. This data set forms a matrix that consists of 29,865 rows and two columns and includes all ZIP codes of the United States and the predicted annual number of USAR contracts per ZIP code. Although not depicted in our sample in Table 4.4, a few of the predicted number of contracts for some ZIP codes were negative. These numbers tended to be extremely small (near zero) and therefore insignificant. Since we are predicting USAR recruit production, we would expect the actual numbers to be integers.

The next thing we did was to compare the Military Available Population to the predicted number of contracts in each of the sample ZIP codes.

ZIP code	MAP	Constraint One	Constraint One Divided by MAP
01001	2036	1.77377	**0.00087**
01002	20099	4.63289	**0.00023**
01003	54	0.09478	**0.00176**
01005	636	0.57790	**0.00091**
01007	1757	1.48569	**0.00085**
01008	137	0.17200	**0.00126**
01010	380	0.27451	**0.00072**
01011	255	0.20598	**0.00081**
01012	44	0.11905	**0.00271**
01013	4037	2.37309	**0.00059**
01020	4127	3.30787	**0.00080**
01022	511	0.39164	**0.00077**
01026	133	0.22505	**0.00169**
01027	2711	1.91457	**0.00071**
01028	1416	1.20046	**0.00085**
01030	1565	1.42575	**0.00091**
01031	229	0.29206	**0.00128**
01032	27	0.11123	**0.00412**
01033	834	0.74830	**0.00090**
01034	197	0.15944	**0.00081**

Some zip codes have a higher ratio of predicted contracts to the Military Available Population

Table 4.5: Comparison of Military Available Population to Average Annual Contract Predictions in Constraint One

By dividing the Military Available Population (MAP) in each ZIP code by our regression results for Constraint One, we determined that some ZIP codes produce proportionately better results. For example, Table 4.5 shows ZIP code 01002 has a generally large MAP (20099) and has a 4.6 predicted annual number of contracts. ZIP code 01012 has a MAP of only 44 and .12 predicted annual number of contracts. However, when we divided the MAP by the predicted annual number of contracts, we see a higher ratio in ZIP code 01012, perhaps indicating a higher preponderance to join the Army.

3. Constraint Two

$$\sum_{r} ZIPFLOW_{z,r,m} \leq max\_recruit\_zip\_MOS_{z,m} \qquad \forall z, m$$

Once we determined the correct model to use for the first constraint, we ran the model using each individual MOS as the dependent variable against the "full" model with

the 24 regressor variables. This required us to run 264 regressions to populate the second constraint. Table 4.5 below shows sample results for the first twenty ZIP codes. The complete data set consists of 28,865 ZIP codes and the 264 MOS's of the United States Army Reserve. The complete data sets for constraint one and two have been provided to LTC Brau for inclusion in his optimization model and are posted on the following web site: http://diana.cs.nps.navy.mil/~dholwell/thesis/tatro/constraints.xls.

ZIP Code/MOS	MAP	52D	77F	88M	95B	96B
01001	2036	4.46	6.07	6.25	5.77	3.99
01002	20099	12.21	15.10	15.37	14.73	12.07
01003	54	0.09	0.06	0.06	0.06	0.09
01005	636	2.24	2.78	2.86	2.65	1.91
01007	1757	4.42	6.26	6.43	5.95	4.03
01008	137	0.42	0.55	0.56	0.52	0.36
01010	380	1.17	1.46	1.51	1.40	1.00
01011	255	0.81	0.94	0.97	0.91	0.68
01012	44	0.19	0.22	0.22	0.21	0.18
01013	4037	6.12	8.52	8.80	8.04	5.38
01020	4127	9.03	12.56	12.99	11.88	7.96
01022	511	0.55	0.75	0.78	0.71	0.50
01026	133	0.69	0.81	0.84	0.78	0.59
01027	2711	4.99	6.78	6.97	6.47	4.49
01028	1416	4.40	5.21	5.32	5.09	3.94
01030	1565	3.51	4.80	4.95	4.57	3.17
01031	229	1.29	1.59	1.65	1.51	1.09
01032	27	0.16	0.14	0.14	0.14	0.15
01033	834	2.20	2.84	2.92	2.74	1.95
01034	197	0.53	0.62	0.63	0.59	0.45

Table 4.6: Sample of Maximum Number of Recruits by ZIP code and MOS

Table 4.6 shows some interesting results. ZIP code 01002 (Amherst, MA), and ZIP codes 01013 and 01020 (Chicopee, MA), tend to produce a higher number of contracts than other ZIP codes in the representative data set. In fact, ZIP code 01032 (Goshen, MA) with a local population of only about 212[12] is likely not to produce any annual enlistment contracts for the USAR. This information is useful for OCAR and USAR recruiters to have if they would like to target certain areas for advertising and

12 City-Data.com Web Site (Retrieved 14 May 05). Retrieved from http://www.city-data.com/zips/01032.html.

recruitment efforts for shortage MOS’s. For example, if a USAR transportation unit was suffering from a shortage of truck drivers (MOS 88M), they could expand or increase their recruitment efforts in Amherst and Chicopee, MA and not spend much effort in other less-productive ZIP code areas.

B. CONSTRAINT ANALYSIS

Once the first two constraints data sets were constructed, we analyzed the results to determine variability between ZIP codes, their demographics, and enlistment contracts. We can prove that demographic composition makes a difference in the placement of TPU’s by showing there is a significant amount of variance between ZIP codes and MOS’s.

Using Microsoft Excel and importing the S-Plus constraint data, we divided the constraint two data by the constraint one data. By doing so, this allows us to obtain a percentage of qualified applicants (based on ASVAB scores) for each MOS and ZIP code. Before we can do this, the data set needs to be “normalized,” meaning that the variables in each constraint must be “equal” for comparison. The data set for the first constraint included a regression model based only on USAR contracts, but the constraint two data set included predictions for qualified candidates for each MOS for all of the Army components (ARNG/USAR/RA). The data set was “normalized” by including the Army National Guard and Regular Army contracts for each of the ZIP codes and their corresponding MOS. Once this was done, the regression model was re-run for constraint one, giving us the normalized data set.

		Cities/ZIP Codes									
		Monterey, CA	Salinas, CA	Buffalo, NY	Tomah, WI	Newport, VT	Butte, MT	Atlanta, Ga	Tombstone, AZ	Montgomery, Al	Bainbridge Island, WA
		93940	93955	14201	54660	05857	59701	30316	85638	36106	98110
MOS's	52D	6.35	8.19	0.61	5.43	0.55	11.35	4.38	1.24	3.22	2.82
	74D	7.12	9.53	1.24	5.86	0.57	12.61	6.32	1.33	3.67	2.99
	77F	8.45	12.31	2.62	7.38	0.69	15.71	11.23	1.66	4.54	3.23
	88M	8.65	12.77	2.79	7.63	0.7	16.18	11.85	1.72	4.67	3.29
	95B	8.12	11.49	2.18	6.93	0.66	14.84	9.5	1.56	4.30	3.18
52D	Const 2	6.35	8.19	0.61	5.43	0.55	11.35	4.38	1.24	3.22	2.82
	Const 1	9.35	14.44	4.14	8.19	0.72	17.63	15.92	1.82	5.24	3.25
		0.68	**0.57**	**0.15**	**0.66**	**0.76**	**0.64**	**0.28**	**0.68**	**0.61**	**0.87**
74D	Const 2	7.12	9.53	1.24	5.86	0.57	12.61	6.32	1.33	3.67	2.99
	Const 1	9.35	14.44	4.14	8.19	0.72	17.63	15.92	1.82	5.24	3.25
		0.76	**0.66**	**0.30**	**0.72**	**0.79**	**0.72**	**0.40**	[illegible]	[illegible]	**0.92**
77F	Const 2	8.45	12.31	2.62	7.38	0.69	15.	[illegible]	[illegible]	[illegible]	[illegible]
	Const 1	9.35	14.44	4.14	8.19	0.72	17.	[illegible]	[illegible]	[illegible]	[illegible]
		0.90	**0.85**	**0.63**	**0.90**	**0.95**	**0.**	[illegible]	[illegible]	[illegible]	[illegible]
88M	Const 2	8.65	12.77	2.79	7.63	0.70	16.	[illegible]	[illegible]	[illegible]	[illegible]
	Const 1	9.35	14.44	4.14	8.19	0.72	17.	[illegible]	[illegible]	[illegible]	[illegible]
		0.92	**0.88**	**0.67**	**0.93**	**0.97**	**0.**	[illegible]	[illegible]	[illegible]	[illegible]
95B	Const 2	8.12	11.49	2.18	6.93	0.66	14.84	9.50	1.56	4.30	3.18
	Const 1	9.35	14.44	4.14	8.19	0.72	17.63	15.92	1.82	5.24	3.25
		0.87	**0.80**	**0.53**	**0.85**	**0.91**	**0.84**	**0.60**	**0.86**	**0.82**	**0.98**

87% of the recruits from Bainbridge, WA qualified for MOS 52D while only 28% from Atlanta, GA qualified for this MOS. This suggests variance between market segments.

Table 4.7: Excel Data sheet depicting variance between the largest five USAR MOS's and ten sample ZIP codes

Table 4.7 shows a data set constructed in Microsoft Excel that shows the regression results for the largest five USAR MOS's and ten sample ZIP codes. The third row for each of the MOS's shows the percentage of recruits that were qualified for the given MOS by ZIP code.

52D		*74D*		*77F*		*88M*		*95B*	
Mean	0.59	Mean	0.67	Mean	0.86	Mean	0.89	Mean	0.80
Standard Error	0.07	Standard Error	0.06	Standard Error	0.04	Standard Error	0.03	Standard Error	0.04
Median	0.65	Median	0.72	Median	0.90	Median	0.92	Median	0.84
Std Deviation	**0.22**	Std Deviation	**0.18**	Std Deviation	**0.11**	Std Deviation	**0.10**	Std Deviation	**0.14**
Sample Variance	0.05	Sample Variance	0.03	Sample Variance	0.01	Sample Variance	0.01	Sample Variance	0.02
Range	0.72	Range	0.62	Range	0.36	Range	0.34	Range	0.45
Minimum	0.15	Minimum	0.30	Minimum	0.63	Minimum	0.67	Minimum	0.53
Maximum	0.87	Maximum	0.92	Maximum	1.00	Maximum	1.01	Maximum	0.98

Table 4.8: Summary Statistics for MOS's in Table 4.7

Table 4.8 details the summary statistics constructed in S-Plus and imported into a Microsoft Excel spreadsheet for the top five USAR MOS's depicted in Table 4.7. Of particular interest is the "mean" value, which shows the average proportion of recruits qualified for each MOS for all 29,865 ZIP codes in the United States. The standard deviation row shows the standard deviation among the numbers of recruits qualified for

each of the MOS's across the ZIP codes in the United States. For example, only 15% ("minimum" value) of the recruits qualified for MOS 52D in at least one of the ZIP codes, while 87% ("maximum" value) of recruits qualified in at least one other ZIP code. The same type of variability holds true for the other MOS's depicted. This shows that there is indeed variance between ZIP codes and numbers of qualified candidates within the Military Available Population (MAP) for the given MOS's.

Inspection of our results shows that there was at least one observation of MOS 88M where more recruits were contracted for this MOS than were qualified (maximum value of 101%). This type of anomaly can be expected since quite frequently in recruiting ASVAB line-score "waivers" are allowed for otherwise fully qualified candidates. For example, an applicant who possesses a Bachelor's degree in Criminal Justice but fails to achieve an ASVAB score high enough to qualify for MOS 95B (Military Policeman), may be allowed a waiver provided he was close to achieving a qualifying score.

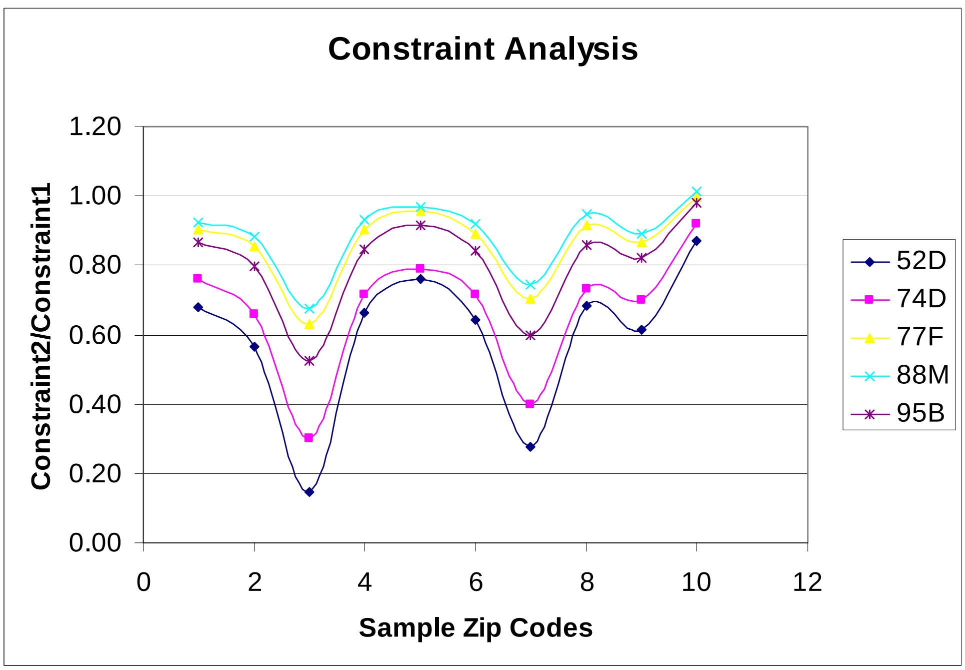

Figure 6. Constraint Analysis for the Top Five USAR MOS's

Figure 6 shows a Microsoft Excel spreadsheet graph for the top five MOS's in the Army Reserve. The X-axis depicts the ten sample ZIP codes and the Y-axis shows the percentage number of recruits qualified for each MOS in the ten sample ZIP codes.

While there seems to be a consistent pattern in terms of qualified candidates for each MOS, there is variance between ZIP codes. The variance between the parallel lines indicate that recruiting efforts can be more productive in some ZIP codes if we are looking to enlist qualified applicants for a specific MOS.

To validate the hypothesis that there is variance among ZIP codes and recruit production by MOS, we studied five more sample MOS populations. This time we included some low-density MOS's for comparison. For our analysis to be correct on our first model, we would expect that a smaller percentage of recruits would qualify for these MOS's since lower density MOS's are generally more technical in nature and require a higher ASVAB score. Table 4.9 shows the results for the following MOS's: 98G (Linguist), 96B (Intelligence Analyst), 33W (Intelligence Systems Repairer-Maintainer), 31S (Satellite Communications Systems Operator-Maintainer), and 11B (Infantryman). MOS 11B was included because it provides a basis of comparison for some of the more technical MOS's and we would expect that more recruits would qualify for this MOS.

Cities/ZIP Codes

MOS's	Monterey, CA 93940	Salinas, CA 93955	Buffalo, NY 14201	Tomah, WI 54660	Newport, VT 05857	Butte, MT 59701	Atlanta, Ga 30316	Tombstone, AZ 85638	Montgomery, Al 36106	Bainbridge Island, WA 98110
98G	8.12	11.49	2.18	6.93	0.66	14.84	9.5	1.56	4.3	3.18
96B	6.02	7.62	0.61	4.68	0.46	10.21	3.94	1.07	3.04	2.72
33W	3.4	3.93	0	2.19	0.19	5.09	0.91	0.51	1.76	1.72
31S	2	2.17	0	1.11	0.1	2.74	0.36	0.26	1.11	1.04
11B	8.5	12.39	2.47	7.43	0.69	15.71	10.79	1.67	4.50	3.31

MOS		Monterey, CA	Salinas, CA	Buffalo, NY	Tomah, WI	Newport, VT	Butte, MT	Atlanta, Ga	Tombstone, AZ	Montgomery, Al	Bainbridge Island, WA
98G	Const 2	8.12	11.49	2.18	6.93	0.66	14.84	9.50	1.56	4.30	3.18
	Const 1	[illegible]	[illegible]	[illegible]	8.19	0.72	17.63	15.92	1.82	5.24	3.25
		[illegible]	[illegible]	[illegible]	**0.85**	**0.91**	**0.84**	**0.60**	**0.86**	**0.82**	**0.98**
96B	Const 2	[illegible]	[illegible]	[illegible]	4.68	0.46	10.21	3.94	1.07	3.04	2.72
	Const 1	[illegible]	[illegible]	[illegible]	8.19	0.72	17.63	15.92	1.82	5.24	3.25
		[illegible]	[illegible]	[illegible]	**0.57**	**0.64**	**0.58**	[illegible]	[illegible]	[illegible]	**0.84**
33W	Const 2	3.40	3.93	0.00	2.19	0.19	5.09	[illegible]	[illegible]	[illegible]	1.72
	Const 1	9.35	14.44	4.14	[illegible]	0.72	17.63	[illegible]	[illegible]	[illegible]	3.25
		0.36	**0.27**	**0.00**	[illegible]	**0.26**	**0.29**	[illegible]	[illegible]	[illegible]	**0.53**
31S	Const 2	2.00	2.17	0.00	1.11	0.10	2.74	0.36	[illegible]	1.11	1.04
	Const 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		0.21	**0.15**	**0.00**	**0.14**	**0.14**	**0.16**	**0.02**	[illegible]	**0.21**	**0.32**
11B	Const 2	8.50	12.39	2.47	7.43	0.69	15.71	10.79	1.67	4.50	3.31
	Const 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		0.91	**0.86**	**0.60**	**0.91**	**0.95**	**0.89**	**0.68**	**0.92**	**0.86**	**1.02**

Fewer numbers of recruits qualified for the most technical MOS's in the data set (31S and 33W)

More recruits qualify for MOS 11B than the other sample MOS's

Table 4.9: Excel Data sheet depicting variance between sample including low density MOS's of the USAR and ZIP codes

Table 4.9 shows the regression results for our low-density MOS sample set and the same ZIP codes as the previous table. As we would expect, the most technical MOS's (31S and 33W) had a much smaller percentage of recruits qualify for enlistment compared to the other MOS's in Tables 4.7 and 4.9.

98G		*96B*		*33W*		*31S*		*11B*	
Mean	0.80	Mean	0.54	Mean	0.27	Mean	0.15	Mean	0.86
Standard Error	0.04	Standard Error	0.06	Standard Error	0.05	Standard Error	0.03	Standard Error	0.04
Median	0.84	Median	0.58	Median	0.28	Median	0.15	Median	0.90
Std Deviation	**0.14**	Std Deviation	**0.20**	Std Deviation	**0.15**	Std Deviation	**0.09**	Std Deviation	**0.13**
Sample Variance	0.02	Sample Variance	0.04	Sample Variance	0.02	Sample Variance	0.01	Sample Variance	0.02
Range	0.45	Range	0.69	Range	0.53	Range	0.32	Range	0.42
Minimum	0.53	Minimum	0.15	Minimum	0.00	Minimum	0.00	Minimum	0.60
Maximum	0.98	Maximum	0.84	Maximum	0.53	Maximum	0.32	Maximum	1.02

Table 4.10: Summary Statistics for MOS's in Table 4.9

Table 4.10 details the summary statistics for the low-density MOS sample in table 4.9. As would be expected the two most technical MOS's (31S and 33W) have the lowest "mean" score, which means that smaller numbers of recruits qualified for enlistment into this MOS. These MOS's also have the highest variance-to-mean ratio compared to the other MOS's. The MOS 11B (Infantryman), which has the lowest ASVAB requirements, had 86% of the recruits qualify for enlistment, the largest percentage in this data set.

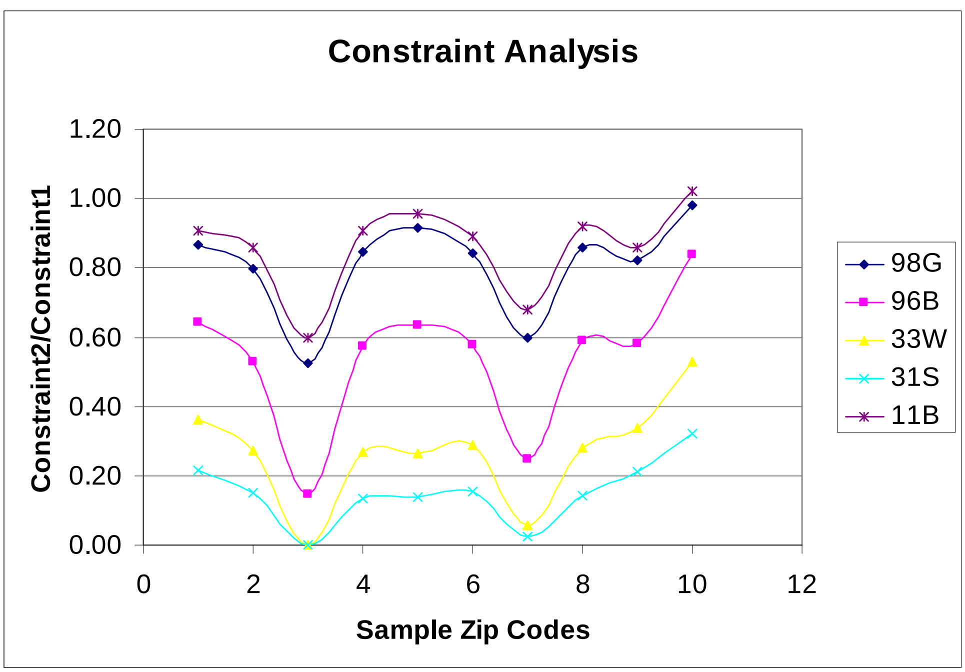

Figure 7. Constraint Analysis for Low-Density MOS's of the USAR

Figure 7 shows a Microsoft Excel spreadsheet for some of the low-density MOS's in the Army Reserve. The X-axis depicts the ten sample ZIP codes and the Y-axis shows the percentage number of recruits qualified for each MOS in each of the sample ZIP codes. Once again, we see that the MOS's 31S and 33W have a much smaller percentage of recruits qualify for these highly technical specialties. MOS 11B (Infantryman) has the highest number of recruits qualify for this MOS followed by 98G (Linguist) and 96B (Intelligence Analyst).

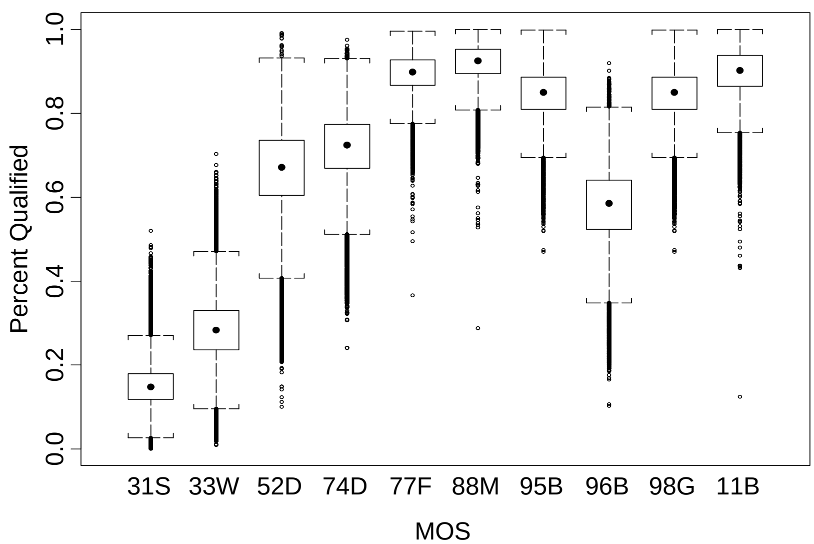

Figure 8. Box plot depicting the Percentage of Recruits qualified for the 10 Sample MOS's for all 29,865 ZIP Codes

The last thing we did was construct a box plot in S-Plus of the ten sample MOS's for all 29,865 ZIP codes. The centers of the boxes indicate the median number (in percent) of Army applicants (USAR/RA/ARNG) that qualified for the MOS based on their ASVAB scores. The top of the box represents the 75th percentile range and the bottom of the box indicates the 25th percentile range. The "box whiskers," shown by the horizontal dashed lines at the top and bottom of the box indicates the one-and-a-half inner quartile ranges (IQR). For example, low density MOS's such as 31S (Satellite Communications Systems Operator-Maintainer) and 33W (Intelligence and Electronic Warfare System Repairer) had a significantly lower number of applicants qualify for the job when compared to some of the higher density MOS's such as 77F (Petroleum Supply

Specialist) and 88M (Motor Transport Operators). One surprising result was for MOS 98G Voice Interceptor (Linguist). Based on ASVAB score alone, about 80% of recruits that took the ASVAB qualified for this MOS. Taken alone, this fact is misleading since 98G's are subject to additional entry requirements such as the Defense Language Aptitude Test (DLAT), which tests an applicant's aptitude to learn a foreign language, and the recruit must be able to qualify for a Top Secret security clearance.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

In his thesis, LTC Fair surmised that demographics matter in terms of TPU placement and the corresponding unit fill-rate. He spent several months constructing a data warehouse and formulating a model to test this hypothesis. His research and model formulation was instrumental to completion of this thesis.

Based on his initial results and findings, this thesis was able to validate LTC Fair's findings that recruit production varies by ZIP code demographics and we constructed the data sets needed for the third and perhaps final thesis. Additionally, we were able to show that demographics matter in terms of recruiting for a specific MOS in the various market segments and that demographics play an important role in determining the percentage of qualified recruits by MOS and ZIP code. We provided a sample of ten MOS's to illustrate this concept.

B. RECOMMENDATIONS

1. The data sets for the first two constraints are complete and up to the limit of the source data, accurately depict the predicted number of USAR enlistment contracts by ZIP code and MOS. In the third thesis, LTC Brau, should use these data sets for his constraints in order to run the optimization model for placement of USAR Troop Program Units.

2. In this thesis, we were able to show that demographics play an important role in determining the percentage of qualified recruits by MOS and ZIP code. OCAR could benefit by this study by using this information and comparing it to existing Market Supportability Studies.

3. The data set used for these three theses is based on six years of data culminating in June 2004 and the identification codes for the Military Occupational Specialties have changed and are continually changing. Early on in the construction of this thesis, the data set was updated to reflect some of these changes but these changes were later abandoned to allow for consistent analysis of data between the three theses.

For this study to be a useful tool for OCAR to examine fill-rate potential and TPU placement the data sets must be updated and kept current.

4. The expected number of recruits per ZIP code provides a possible tool for assessing the effectiveness of recruiting efforts. This information could benefit OCAR by comparing these results to existing Market Supportability Studies and determining areas that may be worthy of increased recruiting efforts.

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[2] McCloskey, Michele A., An Analysis of the Effects of Deployment on Turnover in the United States Army Reserve, Master's Thesis, Naval Postgraduate School, Monterey California, March 1999.

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[4] Headquarters, Department of the Army. *Army Regulation 220-1: Unit Status and Reporting*. Washington, DC: Government Printing Office, 1999.

[5] Hogg, R. V. and E. A. Tanis, *Probability and Statistical Inference*, 3rd Edition. New York, NY: Macmillan Publishing Company, 1988.

[6] Devore, Jay L., *Probability and Statistics for Engineering and the Sciences,* Sixth Edition. Belmont, CA: Brooks/Cole, 2004.

[7] Also used were the following analytical tools and software:

S-Plus version 6.2
Microsoft Word
Microsoft Powerpoint
Microsoft Excel
Microsoft Excel Analysis Tools

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APPENDIX A: OCCUPATIONS AND WORKING CLASS CATEGORIES

White Collar Category Occupations

Executive and Managerial: [EXECMNGE]
Legislators
Chief Executives and General Administrators, Public Administration
Administrators and Officials, Public Administration
Administrators, Protective Services
Financial Managers
Personnel and Labor Relations Managers
Purchasing Managers
Managers, Marketing, Advertising, and Public Relations
Administrators, Education and Related Fields
Managers, Medicine and Health
Managers, Properties and Real Estate
Postmasters and Mail Superintendents
Funeral Directors
Managers and Administrators
Management Related Occupations

Professional Specialty: [PROFSNL]
Mathematical and Computer Scientists
Natural Scientists
Architecture and Engineering Occupations
Architects, Surveyors, Cartographers, and Engineers
Health Diagnosing Occupations
Health Assessment & Treating Occupations
Teachers, Post-secondary
Teachers, except Post-secondary
Counselors, Educational and Vocational Librarians, Archivists, and Curators
Social Scientists and Urban Planners
Social, Recreation, and Religious Workers

Technical Support: [TECHSPT]
Health Technologists and Technicians
Technologists & Technicians, except Health
Drafters, Engineering, and Mapping Technicians
Science Technicians
Technicians, except Health, Engineering, and Science

Sales Occupations: [SALES]
Supervisors and Proprietors
Sales Occupations
Sales Representatives
Commodities except Retail
Sales Workers, Retail and Personal Services and Sales Related Occupations

Administrative Support: [ADMINSPT]
Supervisors
Administrative Support Occupations
Computer Equipment Operators
Secretaries, Stenographers, and Typists
Information Clerks
Records Processing Occupations, except Financial
Financial Records Processing Occupations
Duplicating, Mail & Other Office Machine Operators
Communications Equipment Operators
Mail and Message Distributing Occupations
Material Recording, Scheduling, and Distributing Clerks
N.E.C.
Adjusters and Investigators
Miscellaneous Administrative Support Occupations

Blue Collar Category Occupations

Farm, Forestry & Fish: [FAFOFISH]
Farm Operators and Managers
Other Agricultural and Related Occupations
Forestry and Logging Occupations
Fishers, Hunters, and Trappers

Laborers: [LABORERS]
Supervisors, Handlers, Equipment Cleaners Helpers, Mechanics and Repairers
Helpers, Construction and Extractive Occupations Construction Laborers
Production Helpers
Freight Stock and Materials Handlers
Garage and Service Station, Related Occupations
Vehicle Washers and Equipment Cleaners
Hand Packers

Other Service (except Protective & Household): [SVCOTHR]
Arts, Design, Entertainment, Sports, and Media Occupations
Food Service Preparation and Service Occupations
Health Service Occupations
Cleaning and Building Service Occupations, except Household
Personnel Service Occupation
Launderers and Ironers
Cooks, Private Household
Housekeepers and Butlers
Childcare Workers, Private Households Private Household Cleaners and Servants

Precision Craftsmen: [CRFTSMAN]
Mechanics and Repairers
Construction Trades
Construction Trades, except Supervisors
Extractive Occupations
Precision Production Occupation
Precision Woodworking
Precision Textile, Apparel, and Furnishings Machine Operators
Precision Food Production
Precision Inspectors, Testers, and Related Workers
Plant and System Operators
Metal Working and Plastic Working Machine Operators Fabricating Machine Operators
Metal and Plastic Processing Machine Operators Woodworking Machine Operators
Printing Machine Operators
Textile, Apparel, and Furnishing Operators Machine Operators, Assorted Materials

Protective Service: [SVCPROT]
Supervisors, Protective Service Occupation
Firefighting and Fire Prevention
Police and Detectives
Guards

Transportation & Material Moving: [TRANSPO]
Aircraft and Traffic Control Operators
Motor Vehicle Operators
Transportation Occupations, except Motor Vehicles
Railroad Transportation
Water Transportation
Material Moving Equipment Operators
Production, Transportation, and Material Moving Occupations
Operating Engineers
Long Shore
Hoist & Winch Operators Crane & Tower Operators

P050 TABLE NUMBER & DESCRIPTION

MALE	FEMALE	DESCRIPTION	CATEGORY
P050002	P050049	Total in Population	
P050003	P050050	Management, professional, and related occupations	EXECMNGE
P050004	P050051	Management, business, and financial operations occupations	EXECMNGE
P050005	P050052	Management occupations, except farmers and farm managers	EXECMNGE
P050006	P050053	Farmers and farm managers	FAFOFISH
P050007	P050054	Business and financial operations occupations	EXECMNGE
P050008	P050055	Business operations specialists	ADMINSPT
P050009	P050056	Financial specialists	ADMINSPT
P050010	P050057	Professional and related occupations	PROFSNL
P050011	P050058	Computer and mathematical occupations	PROFSNL
P050012	P050059	Architecture and engineering occupations	PROFSNL
P050013	P050060	Architects, surveyors, cartographers, and engineers	PROFSNL
P050014	P050061	Drafters, engineering, and mapping technicians	TECHSPT
P050015	P050062	Life, physical, and social science occupations	PROFSNL
P050016	P050063	Community and social services occupations	PROFSNL
P050017	P050064	Legal occupations	PROFSNL
P050018	P050065	Education, training, and library occupations	PROFSNL
P050019	P050066	Arts, design, entertainment, sports, and media occupations	SVCOTHR
P050020	P050067	Healthcare practitioners and technical occupations	TECHSPT
P050021	P050068	Health diagnosing and treating practitioners and technical occupations	PROFSNL
P050022	P050069	Health technologists and technicians	TECHSPT
P050023	P050070	Service occupations	SVCOTHR
P050024	P050071	Healthcare support occupations	TECHSPT
P050025	P050072	Protective service occupations	SVCPROT
P050026	P050073	Fire fighting, prevention, and law enforcement workers, including supervisors	SVCPROT
P050027	P050074	Other protective service workers, including supervisors	SVCPROT
P050028	P050075	Food preparation and serving related occupations	SVCOTHR
P050029	P050076	Building and grounds cleaning and maintenance occupations	SVCOTHR

MALE	FEMALE	DESCRIPTION	CATEGORY
P050030	P050077	Personal care and service occupations	SVCOTHR
P050031	P050078	Sales and office occupations	SALES
P050032	P050079	Sales and related occupations	SALES
P050033	P050080	Office and administrative support occupations	ADMINSPT
P050034	P050081	Farming, fishing, and forestry occupations	FAFOFISH
P050035	P050082	Construction, extraction, and maintenance occupations	CRFTSMAN
P050036	P050083	Construction and extraction occupations	CRFTSMAN
P050037	P050084	Supervisors, construction and extraction workers	LABORERS
P050038	P050085	Construction trades workers	CRFTSMAN
P050039	P050086	Extraction workers	CRFTSMAN
P050040	P050087	Installation, maintenance, and repair occupations	CRFTSMAN
P050041	P050088	Production, transportation, and material moving occupations	TRANSPO
P050042	P050089	Production occupations	TRANSPO
P050043	P050090	Transportation and material moving occupations	TRANSPO
P050044	P050091	Supervisors, transportation and material moving workers	TRANSPO
P050045	P050092	Aircraft and traffic control occupations	TRANSPO
P050046	P050093	Motor vehicle operators	TRANSPO
P050047	P050094	Rail, water and other transportation occupations	TRANSPO
P050048	P050095	Material moving workers	TRANSPO

NOTE: Tables and Descriptions provided by the US Bureau of the Census

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APPENDIX B: MICROVISION 50 LIFESTYLE SEGMENTS

SEG #	SEGMENT NAME	SEGMENT DESCRIPTION	GRP #	GROUP NAME
1	Upper Crust	Metropolitan couples and families, very high income and education, homeowners, very high property values, managers/ professionals	1	Accumulated Wealth
2	Lap of Luxury	Families, teens, very high income and education, homeowners, managers/ professionals, 2-worker families	1	Accumulated Wealth
3	Established Wealth	School-age families, high income. high education, homeowners, managers and professionals	1	Accumulated Wealth
4	Mid-Life Success	Families with high education, high income, managers/professionals, technical/sales	1	Accumulated Wealth
5	Prosperous Metro Mix	Families with young children, high education, high income, managers/professionals, technical/sales	1	Accumulated Wealth
6	Good Family Life	Families, children age 5-17, very high education, high income, executives, managers/professionals, technical/sales, home owners	1	Accumulated Wealth
7	Comfortable Times	Middle-aged heads of household, families, high income, medium-high education, technical/sales, managers/professionals	6	Conservative Classics
8	Movers and Shakers	Singles and couples, students and recent graduates, high education and income, managers/professionals, technical/sales	4	Mainstream Singles
9	Building a Home Life	School-age families, new housing, medium-high education, technical/sales, managers/professionals	3	Young Accumulators
10	Home Sweet Home	Married Couples, one or no children, some retirees, medium-high income and education, managers/ professionals, technical/sales	2	Mainstream Families
11	Family Ties	Large families, medium education, medium-high income, technical/sales, Precision/crafts, two workers	2	Mainstream Families
12	A Good Step Forward	Mobile singles, high education, medium income, often renters, managers/professionals, technical/sales	4	Mainstream Singles
13	Successful Singles	Urban areas, renters, young singles and couples, older housing, ethnic	9	Sustaining Singles

SEG #	SEGMENT NAME	SEGMENT DESCRIPTION	GRP #	GROUP NAME
		mix, high education, medium income, managers/ professionals		
14	Middle Years	Mid-life couples, families, medium-high education, mixed occupations. medium income	1	Accumulated Wealth
15	Great Beginnings	Young, singles and couples, medium-high education, medium income, some renters, managers/professionals, technical/sales	4	Mainstream Singles
16	Country Home Families	Large families, rural areas, medium education, medium income, precision/crafts - trades	2	Mainstream Families
17	Stars and Stripes	Young heads of household, large families with school-age children, medium income and education, some military, precision/craft	2	Mainstream Families
18	White Picket Fence	Young families, low to medium education, medium income, precision/crafts, laborers	2	Mainstream Families
19	Young and Carefree	Young, singles and couples, no kids, medium income, medium-high education technical/sales, managers/ professionals	3	Young Accumulators
20	Secure Adults	Mature/seniors, metro fringe areas, singles and couples, medium income, medium education, mixed occupations and some retirees	6	Conservative Classics
21	American Classics	Seniors, singles and couples, no kids, suburban areas, medium income, medium education, mixed occupations and some retirees	6	Conservative Classics
22	Traditional Times	Seniors, no kids, low education levels, medium income, laborers, precision/crafts workers, some retirees	2	Mainstream Families
23	Settled In	Empty nesters, no kids, medium education and income, some retirees, technical/sales and service occupations	2	Mainstream Families
24	City Ties	School-age families, urban areas, African-American, average income, average education, service and laborer occupations	8	Sustaining Families
25	Bedrock America	School-age families, medium income, low-medium education, precision/crafts, military, laborers	3	Young Accumulators
26	The Mature Years	Couples and small families, medium income, low-medium education, precision/crafts, laborers	7	Cautious Couples
27	Middle of the	School-age families, medium income,	5	Asset-

SEG #	SEGMENT NAME	SEGMENT DESCRIPTION	GRP #	GROUP NAME
	Road	mixed education levels, mixed education levels, mixed occupations		Building Families
28	Building a Family	Families, school-age children, medium income, medium-low education, mixed occupations	3	Young Accumulators
29	Establishing Roots	Families with kids of all ages, medium income, low education. mixed occupations	5	Asset-Building Families
30	Domestic Duos	Mature/seniors, singles and couples, no kids, medium-low income, mixed housing, medium education, technical/sales, managers/professionals, some retirees	6	Conservative Classics
31	Country Classics	Middle-aged to mature heads of household, seniors, medium-low income, low education, some mobile homes, laborers	6	Conservative Classics
32	Metro Singles	Singles, renters, urban areas, multi-unit housing, low education, medium-low income, technical/sales, laborers	4	Mainstream Singles
33	Living Off the Land	Rural areas, school-age families, medium-low income, low education, farming/fishing, laborers	7	Cautious Couples
34	Books and New Recruits	Young, high education, medium-low income, students, managers/professionals, service occupations, some military, renters	4	Mainstream Singles
35	Buy American	Families with school-age kids, medium-low income, low education, laborers	2	Mainstream Families
36	Metro Mix	Young singles, no kids, ethnic mix, medium-low income, mostly renters, multi-unit housing, use public transportation	9	Sustaining Singles
37	Urban Up and Comers	Young, singles, ethnic mix, renters, multi-unit housing, high education, medium-low income, managers/professionals	9	Sustaining Singles
38	Rustic Homesteaders	Rural areas, families, school-age kids, low education, medium-low income, some mobile homes, farming/fishing, laborers	2	Mainstream Families
39	On Their Own	Mix of young and seniors, singles and couples, medium-low income, medium-high education, managers/professionals, technical/sales, some renters	4	Mainstream Singles
40	Trying Metro Times	Mix of young and seniors, urban, ethnic mix, low income, older housing, owners and renter, low education levels, varied occupations.	4	Mainstream Singles

SEG #	SEGMENT NAME	SEGMENT DESCRIPTION	GRP #	GROUP NAME
41	Close Knit Families	Primarily Hispanic, large families, kids of all ages, low income and education, precision/craft occupations and laborers	8	Sustaining Families
42	Trying Rural Times	Large families, ethnic mix, low income and education, some mobile homes, service occupations, laborers	8	Sustaining Families
43	Manufacturing USA	Largely African American, singles and families, older housing, low income and education, service and laborer occupations	8	Sustaining Families
44	Hard Years	Young adults and seniors, low income and education, older multi-unit housing, renters service occupations, laborers	8	Sustaining Families
45	Struggling Metro Mix	Young, singles, urban, cultural mix, renters, low income, mixed education levels, older multi-unit housing	9	Sustaining Singles
46	Difficult Times	Primarily African-American, school-age families, urban areas, very low income, low education, laborers and service occupations	8	Sustaining Families
47	University USA	Students and singles, dorms and group quarters, very low income,-medium-high education, technical/sales	9	Sustaining Singles
48	Urban Singles	Mix of young and seniors, singles, renters, old multi-unit housing, urban areas, very low income, mixed education levels, service occupations, technical/sales	9	Sustaining Singles
49	Anomalies	No homogeneity	10	Anomalies
50	Unclassified	Post Office Boxes and unclassified population	11	Unclassified

APPENDIX C: CONSTRAINT ONE REGRESSION EQUATIONS

MODEL WITH 24 PREDICTORS: UNEMPL RATE, MAP, LIFESTYLE SEGMENTS, AND VOCATIONS

```
AR.Cnt/6 ~ unrate.2 + MA.POP + EXECMNGE + FAFOFISH + ADMINSPT + PROFSNL +
TECHSPT + SVCOTHR + SVCPROT +SALES + CRFTSMAN + LABORERS + TRANSPO + MV50GP01 +
MV50GP02 + MV50GP03 + MV50GP04 + MV50GP05 + MV50GP06 + MV50GP07 + MV50GP08 +
MV50GP09 + MV50GP10 + MV50GP11

Residuals:
    Min      1Q   Median     3Q  Max
 -7.229 -0.2106 -0.05927 0.1448 23.3

Coefficients:
                Value Std. Error  t value Pr(>|t|)
(Intercept)   0.1387   0.0151     9.2131   0.0000
   unrate.2  -1.5434   0.2260    -6.8296   0.0000
     MA.POP   0.0001   0.0000    18.5962   0.0000
   EXECMNGE  -0.0002   0.0000   -18.5076   0.0000
   FAFOFISH  -0.0006   0.0000   -13.4248   0.0000
   ADMINSPT   0.0007   0.0000    23.1083   0.0000
    PROFSNL   0.0001   0.0000     4.7457   0.0000
    TECHSPT   0.0008   0.0000    24.3689   0.0000
    SVCOTHR   0.0001   0.0000     8.7385   0.0000
    SVCPROT   0.0003   0.0000     7.6544   0.0000
      SALES   0.0000   0.0000     0.3065   0.7592
   CRFTSMAN  -0.0002   0.0000   -16.6802   0.0000
   LABORERS  -0.0021   0.0003    -7.7205   0.0000
    TRANSPO   0.0000   0.0000     1.4496   0.1472
   MV50GP01   0.0000   0.0000     1.4457   0.1483
   MV50GP02   0.0000   0.0000     5.2419   0.0000
   MV50GP03   0.0015   0.0000    40.9521   0.0000
   MV50GP04   0.0000   0.0000    -8.0048   0.0000
   MV50GP05  -0.0014   0.0002    -6.5834   0.0000
   MV50GP06  -0.0003   0.0000   -14.9506   0.0000
   MV50GP07  -0.0012   0.0003    -4.3709   0.0000
   MV50GP08   0.0001   0.0000    14.9841   0.0000
   MV50GP09  -0.0001   0.0000    -9.2615   0.0000
   MV50GP10  -0.0014   0.0005    -2.5788   0.0099
   MV50GP11   0.0001   0.0001     0.6915   0.4893

Residual standard error: 0.8929 on 29840 degrees of freedom
Multiple R-Squared: 0.6934
F-statistic: 2812 on 24 and 29840 degrees of freedom, the p-value is 0
```

MODEL WITH 23 PREDICTORS: UNEMPL RATE, MAP, LIFESTYLE SEGMENTS, AND VOCATIONS (MINUS SALES)

```
AR.Cnt/6 ~ unrate.2 + MA.POP + EXECMNGE + FAFOFISH + ADMINSPT + PROFSNL +
TECHSPT + SVCOTHR + SVCPROT + CRFTSMAN + LABORERS + TRANSPO + MV50GP01 +
MV50GP02 + MV50GP03 + MV50GP04 + MV50GP05 + MV50GP06 + MV50GP07 + MV50GP08 +
MV50GP09 + MV50GP10 + MV50GP11

Residuals:
   Min      1Q   Median     3Q   Max
 -7.23 -0.2103 -0.05921 0.1446 23.29

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)   0.1385   0.0150     9.2095   0.0000
   unrate.2  -1.5413   0.2259    -6.8235   0.0000
     MA.POP   0.0001   0.0000    19.3729   0.0000
   EXECMNGE  -0.0002   0.0000   -20.2898   0.0000
   FAFOFISH  -0.0006   0.0000   -13.4529   0.0000
   ADMINSPT   0.0007   0.0000    30.3816   0.0000
    PROFSNL   0.0001   0.0000     4.9816   0.0000
    TECHSPT   0.0009   0.0000    25.6810   0.0000
    SVCOTHR   0.0001   0.0000     9.0508   0.0000
    SVCPROT   0.0003   0.0000     7.6570   0.0000
   CRFTSMAN  -0.0002   0.0000   -16.7001   0.0000
   LABORERS  -0.0020   0.0003    -7.7747   0.0000
    TRANSPO   0.0000   0.0000     1.4565   0.1453
   MV50GP01   0.0000   0.0000     1.5119   0.1306
   MV50GP02   0.0000   0.0000     5.3343   0.0000
   MV50GP03   0.0015   0.0000    40.9999   0.0000
   MV50GP04   0.0000   0.0000    -8.0047   0.0000
   MV50GP05  -0.0014   0.0002    -6.5854   0.0000
   MV50GP06  -0.0003   0.0000   -15.1106   0.0000
   MV50GP07  -0.0012   0.0003    -4.3930   0.0000
   MV50GP08   0.0001   0.0000    14.9985   0.0000
   MV50GP09  -0.0001   0.0000    -9.3267   0.0000
   MV50GP10  -0.0014   0.0005    -2.5818   0.0098
   MV50GP11   0.0001   0.0001     0.6959   0.4865

Residual standard error: 0.8929 on 29841 degrees of freedom
Multiple R-Squared: 0.6934
F-statistic: 2934 on 23 and 29841 degrees of freedom, the p-value is 0
```

MODEL MINUS SALES AND TRANSPORTATION:

```
AR.Cnt/6 ~ unrate.2 + MA.POP + EXECMNGE + FAFOFISH + ADMINSPT + PROFSNL +
TECHSPT + SVCOTHR + SVCPROT + CRFTSMAN + LABORERS + MV50GP01 + MV50GP02 +
MV50GP03 + MV50GP04 + MV50GP05 + MV50GP06 + MV50GP07 + MV50GP08 + MV50GP09 +
MV50GP10 + MV50GP11

Residuals:
    Min      1Q   Median     3Q   Max
 -7.259 -0.2105 -0.05925 0.1445 23.28

Coefficients:
                Value Std. Error  t value Pr(>|t|)
(Intercept)   0.1375   0.0150     9.1521   0.0000
   unrate.2  -1.5241   0.2256    -6.7564   0.0000
     MA.POP   0.0001   0.0000    20.0042   0.0000
   EXECMNGE  -0.0002   0.0000   -20.4317   0.0000
   FAFOFISH  -0.0006   0.0000   -13.3951   0.0000
   ADMINSPT   0.0007   0.0000    31.5627   0.0000
    PROFSNL   0.0001   0.0000     4.8461   0.0000
    TECHSPT   0.0009   0.0000    25.9201   0.0000
    SVCOTHR   0.0001   0.0000     9.1188   0.0000
    SVCPROT   0.0003   0.0000     7.5180   0.0000
   CRFTSMAN  -0.0002   0.0000   -16.9107   0.0000
   LABORERS  -0.0021   0.0003    -8.2143   0.0000
   MV50GP01   0.0000   0.0000     1.6635   0.0962
   MV50GP02   0.0000   0.0000     6.0166   0.0000
   MV50GP03   0.0015   0.0000    41.1038   0.0000
   MV50GP04   0.0000   0.0000    -7.9381   0.0000
   MV50GP05  -0.0014   0.0002    -6.4878   0.0000
   MV50GP06  -0.0003   0.0000   -15.3058   0.0000
   MV50GP07  -0.0012   0.0003    -4.3177   0.0000
   MV50GP08   0.0001   0.0000    15.7702   0.0000
   MV50GP09  -0.0001   0.0000    -9.2843   0.0000
   MV50GP10  -0.0014   0.0005    -2.5838   0.0098
   MV50GP11   0.0001   0.0001     0.6782   0.4977

Residual standard error: 0.8929 on 29842 degrees of freedom
Multiple R-Squared: 0.6934
F-statistic: 3067 on 22 and 29842 degrees of freedom, the p-value is 0
```

MODEL WITH 22 PREDICTORS: LIFESTYLE SEGMENTS, AND VOCATIONS (MINUS UNEMPL RATE, MAP)

```
AR.Cnt/6 ~ EXECMNGE + FAFOFISH + ADMINSPT + PROFSNL + TECHSPT + SVCOTHR +
SVCPROT + SALES + CRFTSMAN + LABORERS + TRANSPO + MV50GP01 + MV50GP02 +
MV50GP03 + MV50GP04 + MV50GP05 + MV50GP06 + MV50GP07 + MV50GP08 + MV50GP09 +
MV50GP10 + MV50GP11

Residuals:
    Min      1Q   Median    3Q   Max
 -7.148 -0.2101 -0.05192 0.139 23.37

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)   0.0474   0.0073     6.4573   0.0000
   EXECMNGE  -0.0002   0.0000   -27.3829   0.0000
   FAFOFISH  -0.0005   0.0000   -10.8364   0.0000
   ADMINSPT   0.0007   0.0000    23.2835   0.0000
    PROFSNL   0.0002   0.0000    15.1600   0.0000
    TECHSPT   0.0007   0.0000    20.4029   0.0000
    SVCOTHR   0.0002   0.0000    14.8769   0.0000
    SVCPROT   0.0002   0.0000     5.8940   0.0000
      SALES   0.0001   0.0000     5.1905   0.0000
   CRFTSMAN  -0.0002   0.0000   -14.8204   0.0000
   LABORERS  -0.0022   0.0003    -8.3525   0.0000
    TRANSPO   0.0000   0.0000     4.4124   0.0000
   MV50GP01   0.0000   0.0000    -0.6967   0.4860
   MV50GP02   0.0000   0.0000     2.2211   0.0264
   MV50GP03   0.0015   0.0000    41.3207   0.0000
   MV50GP04   0.0000   0.0000    -7.4549   0.0000
   MV50GP05  -0.0016   0.0002    -7.3367   0.0000
   MV50GP06  -0.0003   0.0000   -17.5194   0.0000
   MV50GP07  -0.0009   0.0003    -3.3589   0.0008
   MV50GP08   0.0001   0.0000    17.3593   0.0000
   MV50GP09   0.0000   0.0000    -7.7435   0.0000
   MV50GP10  -0.0012   0.0005    -2.2099   0.0271
   MV50GP11   0.0001   0.0001     0.7100   0.4777

Residual standard error: 0.8987 on 29842 degrees of freedom
Multiple R-Squared: 0.6893
F-statistic: 3010 on 22 and 29842 degrees of freedom, the p-value is 0
```

MODEL MINUS SALES,TRANSPORTATION, AND MV50GP11:

```
AR.Cnt/6 ~ unrate.2 + MA.POP + EXECMNGE + FAFOFISH + ADMINSPT + PROFSNL +
TECHSPT + SVCOTHR + SVCPROT + CRFTSMAN + LABORERS + MV50GP01 + MV50GP02 +
MV50GP03 + MV50GP04 + MV50GP05 + MV50GP06 + MV50GP07 + MV50GP08 +  MV50GP09 +
MV50GP10

Residuals:
    Min      1Q   Median     3Q   Max
 -7.261 -0.2105 -0.05932 0.1445 23.28

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)   0.1376   0.0150     9.1550   0.0000
   unrate.2  -1.5259   0.2256    -6.7649   0.0000
     MA.POP   0.0001   0.0000    20.0034   0.0000
   EXECMNGE  -0.0002   0.0000   -20.4232   0.0000
   FAFOFISH  -0.0006   0.0000   -13.4935   0.0000
   ADMINSPT   0.0007   0.0000    31.5705   0.0000
    PROFSNL   0.0001   0.0000     4.8377   0.0000
    TECHSPT   0.0009   0.0000    25.9263   0.0000
    SVCOTHR   0.0001   0.0000     9.1143   0.0000
    SVCPROT   0.0003   0.0000     7.5103   0.0000
   CRFTSMAN  -0.0002   0.0000   -16.9086   0.0000
   LABORERS  -0.0021   0.0003    -8.2246   0.0000
   MV50GP01   0.0000   0.0000     1.6578   0.0974
   MV50GP02   0.0000   0.0000     6.0020   0.0000
   MV50GP03   0.0015   0.0000    41.1568   0.0000
   MV50GP04   0.0000   0.0000    -7.9448   0.0000
   MV50GP05  -0.0014   0.0002    -6.5105   0.0000
   MV50GP06  -0.0003   0.0000   -15.3110   0.0000
   MV50GP07  -0.0012   0.0003    -4.3425   0.0000
   MV50GP08   0.0001   0.0000    15.7634   0.0000
   MV50GP09  -0.0001   0.0000    -9.2700   0.0000
   MV50GP10  -0.0014   0.0005    -2.5813   0.0098

Residual standard error: 0.8929 on 29843 degrees of freedom
Multiple R-Squared: 0.6933
F-statistic: 3213 on 21 and 29843 degrees of freedom, the p-value is 0
```

MODEL MINUS SALES,TRANSPORTATION, AND MV50GP11:

```
AR.Cnt/6 ~ unrate.2 + MA.POP + EXECMNGE + FAFOFISH + ADMINSPT + PROFSNL +
TECHSPT + SVCOTHR + SVCPROT + CRFTSMAN + LABORERS + MV50GP01 + MV50GP02 +
MV50GP03 + MV50GP04 + MV50GP05 + MV50GP06 + MV50GP07 + MV50GP08 +  MV50GP09 +
MV50GP10

Residuals:
    Min      1Q   Median     3Q   Max
 -7.261 -0.2105 -0.05932 0.1445 23.28

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)   0.1376   0.0150     9.1550   0.0000
   unrate.2  -1.5259   0.2256    -6.7649   0.0000
     MA.POP   0.0001   0.0000    20.0034   0.0000
   EXECMNGE  -0.0002   0.0000   -20.4232   0.0000
   FAFOFISH  -0.0006   0.0000   -13.4935   0.0000
   ADMINSPT   0.0007   0.0000    31.5705   0.0000
    PROFSNL   0.0001   0.0000     4.8377   0.0000
    TECHSPT   0.0009   0.0000    25.9263   0.0000
    SVCOTHR   0.0001   0.0000     9.1143   0.0000
    SVCPROT   0.0003   0.0000     7.5103   0.0000
   CRFTSMAN  -0.0002   0.0000   -16.9086   0.0000
   LABORERS  -0.0021   0.0003    -8.2246   0.0000
   MV50GP01   0.0000   0.0000     1.6578   0.0974
   MV50GP02   0.0000   0.0000     6.0020   0.0000
   MV50GP03   0.0015   0.0000    41.1568   0.0000
   MV50GP04   0.0000   0.0000    -7.9448   0.0000
   MV50GP05  -0.0014   0.0002    -6.5105   0.0000
   MV50GP06  -0.0003   0.0000   -15.3110   0.0000
   MV50GP07  -0.0012   0.0003    -4.3425   0.0000
   MV50GP08   0.0001   0.0000    15.7634   0.0000
   MV50GP09  -0.0001   0.0000    -9.2700   0.0000
   MV50GP10  -0.0014   0.0005    -2.5813   0.0098

Residual standard error: 0.8929 on 29843 degrees of freedom
Multiple R-Squared: 0.6933
F-statistic: 3213 on 21 and 29843 degrees of freedom, the p-value is 0
```

MODEL MINUS SALES,TRANSPORTATION,MV50GP11, AND MV50GP01:

```
AR.Cnt/6 ~ unrate.2 + MA.POP + EXECMNGE + FAFOFISH + ADMINSPT + PROFSNL +
TECHSPT + SVCOTHR + SVCPROT + CRFTSMAN + LABORERS + MV50GP02 + MV50GP03 +
MV50GP04 + MV50GP05 + MV50GP06 + MV50GP07 + MV50GP08 + MV50GP09 +
MV50GP10

Residuals:
    Min      1Q   Median     3Q   Max
 -7.262 -0.2099 -0.05888 0.1442 23.29

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)   0.1365   0.0150     9.0929   0.0000
   unrate.2  -1.5130   0.2254    -6.7117   0.0000
     MA.POP   0.0001   0.0000    19.9442   0.0000
   EXECMNGE  -0.0002   0.0000   -20.8882   0.0000
   FAFOFISH  -0.0006   0.0000   -13.5076   0.0000
   ADMINSPT   0.0007   0.0000    31.7839   0.0000
    PROFSNL   0.0001   0.0000     4.8883   0.0000
    TECHSPT   0.0009   0.0000    25.9618   0.0000
    SVCOTHR   0.0001   0.0000     9.4247   0.0000
    SVCPROT   0.0003   0.0000     7.5743   0.0000
   CRFTSMAN  -0.0002   0.0000   -16.8496   0.0000
   LABORERS  -0.0021   0.0003    -8.2100   0.0000
   MV50GP02   0.0000   0.0000     5.9096   0.0000
   MV50GP03   0.0015   0.0000    41.1374   0.0000
   MV50GP04  -0.0001   0.0000    -9.8255   0.0000
   MV50GP05  -0.0014   0.0002    -6.3932   0.0000
   MV50GP06  -0.0003   0.0000   -15.3222   0.0000
   MV50GP07  -0.0012   0.0003    -4.3726   0.0000
   MV50GP08   0.0001   0.0000    16.0156   0.0000
   MV50GP09  -0.0001   0.0000   -12.3757   0.0000
   MV50GP10  -0.0013   0.0005    -2.4949   0.0126

Residual standard error: 0.8929 on 29844 degrees of freedom
Multiple R-Squared: 0.6933
F-statistic: 3373 on 20 and 29844 degrees of freedom, the p-value is 0
```

MINUS LIFESTYLE SEGMENTS

```
      *** Linear Model ***

Call: lm(formula = AR.Cnt/6 ~ unrate.2 + MA.POP + EXECMNGE + FAFOFISH +
ADMINSPT + PROFSNL + TECHSPT +
      SVCOTHR + SVCPROT + SALES + CRFTSMAN + LABORERS + TRANSPO, data =
ALLDATAbyZIP2a, na.action =
      na.exclude)
Residuals:
    Min     1Q   Median     3Q   Max
 -6.814 -0.221 -0.08295 0.1265 25.68

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)   0.1671   0.0155    10.7943   0.0000
   unrate.2  -1.6632   0.2354    -7.0649   0.0000
     MA.POP   0.0001   0.0000    19.3142   0.0000
   EXECMNGE  -0.0002   0.0000   -22.1707   0.0000
   FAFOFISH  -0.0006   0.0000   -11.9132   0.0000
   ADMINSPT   0.0005   0.0000    16.5559   0.0000
    PROFSNL   0.0001   0.0000     4.4176   0.0000
    TECHSPT   0.0011   0.0000    29.6812   0.0000
    SVCOTHR   0.0000   0.0000    -0.0943   0.9249
    SVCPROT   0.0007   0.0000    15.8351   0.0000
      SALES   0.0000   0.0000     2.2362   0.0253
   CRFTSMAN  -0.0001   0.0000    -5.7927   0.0000
   LABORERS  -0.0007   0.0003    -2.4892   0.0128
    TRANSPO   0.0001   0.0000    19.8217   0.0000

Residual standard error: 0.9434 on 29851 degrees of freedom
Multiple R-Squared: 0.6576
F-statistic: 4409 on 13 and 29851 degrees of freedom, the p-value is 0
1 observations deleted due to missing values
```

MODEL WITH 13 PREDICTORS: UNEMPL RATE, MAP, LIFESTYLE SEGMENTS (MINUS VOCATIONS)

```
AR.Cnt/6 ~ unrate.2 + MA.POP + MV50GP01 + MV50GP02 + MV50GP03 + MV50GP04 +
MV50GP05 + MV50GP06 + MV50GP07 + MV50GP08 + MV50GP09 + MV50GP10 + MV50GP11

Residuals:
    Min     1Q  Median     3Q   Max
 -7.834 -0.234 -0.0587 0.1524 23.71

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)   0.1706   0.0160    10.6950   0.0000
   unrate.2  -2.5147   0.2399   -10.4836   0.0000
     MA.POP   0.0002   0.0000    36.5349   0.0000
   MV50GP01   0.0001   0.0000    19.5007   0.0000
   MV50GP02   0.0002   0.0000    40.7378   0.0000
   MV50GP03   0.0014   0.0000    38.2361   0.0000
   MV50GP04   0.0001   0.0000    15.1034   0.0000
   MV50GP05  -0.0028   0.0002   -12.4049   0.0000
   MV50GP06  -0.0002   0.0000   -12.0818   0.0000
   MV50GP07  -0.0030   0.0003   -10.8203   0.0000
   MV50GP08   0.0003   0.0000    45.8794   0.0000
   MV50GP09   0.0001   0.0000    13.1959   0.0000
   MV50GP10  -0.0031   0.0006    -5.4805   0.0000
   MV50GP11  -0.0004   0.0001    -3.0002   0.0027

Residual standard error: 0.9596 on 29851 degrees of freedom
Multiple R-Squared: 0.6457
F-statistic: 4186 on 13 and 29851 degrees of freedom, the p-value is 0
```

MODEL WITH 11 PREDICTORS: LIFESTYLE SEGMENTS (MINUS VOCATIONS, UNEMPL RATE, MAP)

```
AR.Cnt/6 ~ MV50GP01 + MV50GP02 + MV50GP03 + MV50GP04 + MV50GP05 + MV50GP06 +
MV50GP07 + MV50GP08 + MV50GP09 + MV50GP10 + MV50GP11

Residuals:
   Min      1Q   Median     3Q   Max
 -8.66 -0.2467 -0.05481 0.1365 23.41

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)   0.0301   0.0078     3.8373   0.0001
   MV50GP01   0.0002   0.0000    35.5405   0.0000
   MV50GP02   0.0003   0.0000    66.3009   0.0000
   MV50GP03   0.0016   0.0000    41.3711   0.0000
   MV50GP04   0.0002   0.0000    49.2990   0.0000
   MV50GP05  -0.0032   0.0002   -13.6898   0.0000
   MV50GP06  -0.0003   0.0000   -16.6614   0.0000
   MV50GP07  -0.0028   0.0003    -9.6608   0.0000
   MV50GP08   0.0004   0.0000    77.1415   0.0000
   MV50GP09   0.0002   0.0000    39.6966   0.0000
   MV50GP10  -0.0040   0.0006    -7.0221   0.0000
   MV50GP11  -0.0002   0.0001    -2.0317   0.0422

Residual standard error: 0.9828 on 29853 degrees of freedom
Multiple R-Squared: 0.6283
F-statistic: 4588 on 11 and 29853 degrees of freedom, the p-value is 0
```

MODEL WITH 11 PREDICTORS: VOCATIONS (MINUS UNEMPL RATE, MAP, LIFESTYLE SEGMENTS)

```
AR.Cnt/6 ~ EXECMNGE + FAFOFISH + ADMINSPT + PROFSNL + TECHSPT + SVCOTHR +
SVCPROT + SALES + CRFTSMAN + LABORERS + TRANSPO

Residuals:
    Min      1Q   Median     3Q   Max
 -6.551 -0.2203 -0.07334 0.1196 25.67

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)   0.0658   0.0072     9.1757   0.0000
   EXECMNGE  -0.0003   0.0000   -30.8645   0.0000
   FAFOFISH  -0.0005   0.0000    -9.6386   0.0000
   ADMINSPT   0.0005   0.0000    18.1043   0.0000
    PROFSNL   0.0002   0.0000    13.9325   0.0000
    TECHSPT   0.0009   0.0000    25.3116   0.0000
    SVCOTHR   0.0001   0.0000    10.6215   0.0000
    SVCPROT   0.0006   0.0000    14.3491   0.0000
      SALES   0.0001   0.0000     4.8564   0.0000
   CRFTSMAN  -0.0001   0.0000    -5.3106   0.0000
   LABORERS  -0.0012   0.0003    -4.1701   0.0000
    TRANSPO   0.0001   0.0000    23.0913   0.0000

Residual standard error: 0.9499 on 29853 degrees of freedom
Multiple R-Squared: 0.6528
F-statistic: 5103 on 11 and 29853 degrees of freedom, the p-value is 0
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MODEL WITH 2 PREDICTORS: UNEMPL RATE AND MAP ONLY (MINUS LIFESTYLE SEGMENTS, AND VOCATIONS)

```
AR.Cnt/6 ~ unrate.2 + MA.POP

Residuals:
    Min      1Q  Median      3Q   Max
 -10.31 -0.2794 -0.1652 0.09793 26.92

Coefficients:
                Value Std. Error   t value  Pr(>|t|)
(Intercept)    0.2801    0.0174    16.1304    0.0000
   unrate.2   -1.8451    0.2678    -6.8888    0.0000
     MA.POP    0.0004    0.0000   188.3463    0.0000

Residual standard error: 1.089 on 29862 degrees of freedom
Multiple R-Squared: 0.5432
F-statistic: 17750 on 2 and 29862 degrees of freedom, the p-value is 0
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